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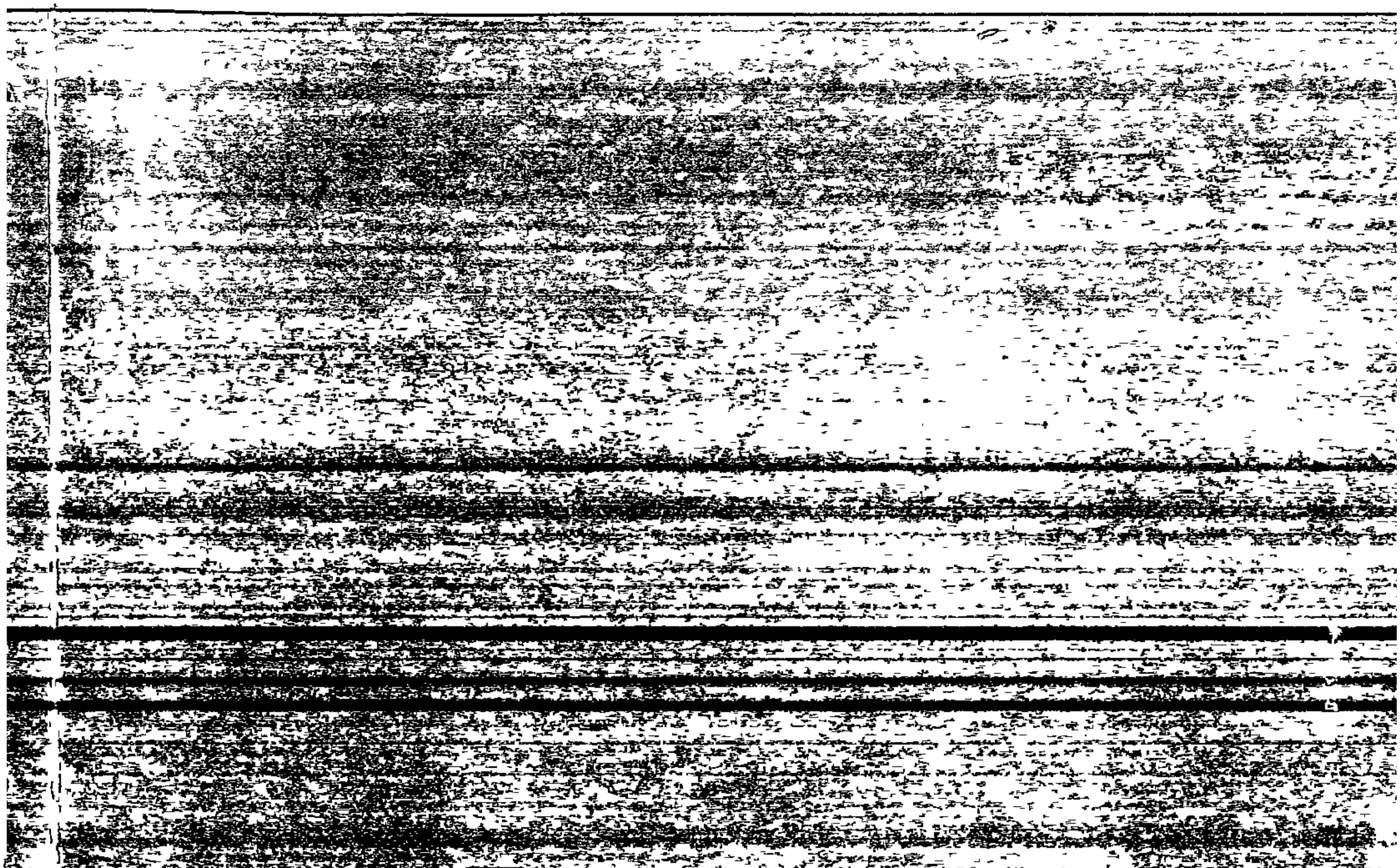
DOUGLAS REPORT DAC-56503





# NARRATIVE END ITEM REPORT

## SATURN S-IVB-210





APRIL 1968

DOUGLAS MISSILE & SPACE SYSTEMS DIVISION

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# SATURN S-IVB-210

**APRIL 1968**

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PREPARED FOR
NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION
UNDER NASA CONTRACT NAS7-101



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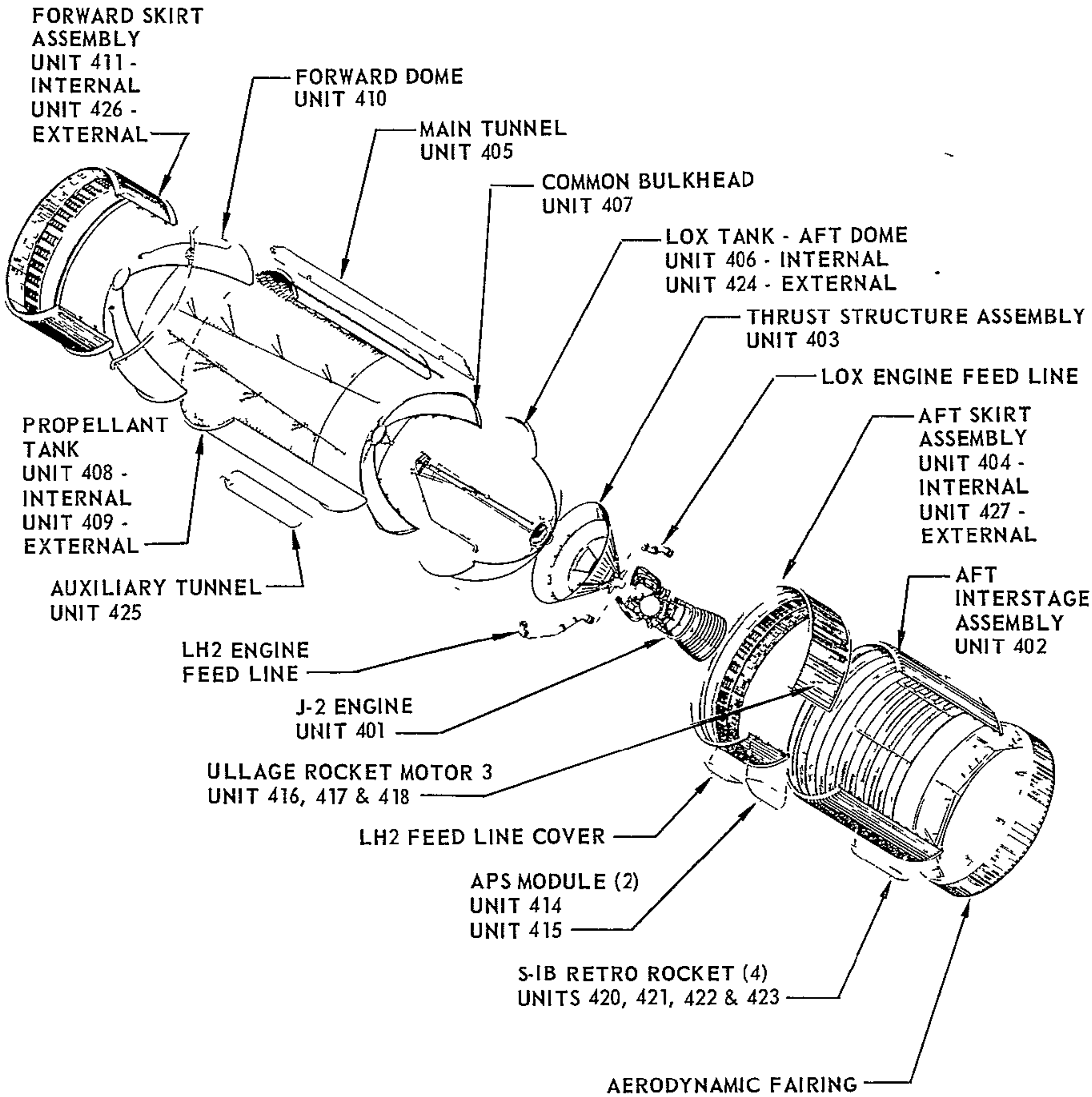
FORWARD SKIRT ASSEMBLY UNIT 411 - INTERNAL UNIT 426 - EXTERNAL
FORWARD DOME UNIT 410
MAIN TUNNEL UNIT 405
COMMON BULKHEAD UNIT 407
LOX TANK - AFT DOME UNIT 406 - INTERNAL UNIT 424 - EXTERNAL
THRUST STRUCTURE ASSEMBLY UNIT 403
LOX ENGINE FEED LINE
AFT SKIRT ASSEMBLY UNIT 404 - INTERNAL UNIT 427 - EXTERNAL
AFT INTERSTAGE ASSEMBLY UNIT 402
PROPELLANT TANK UNIT 408 - INTERNAL UNIT 409 - EXTERNAL
AUXILIARY TUNNEL UNIT 425
LH2 ENGINE FEED LINE
J-2 ENGINE UNIT 401
ULLAGE ROCKET MOTOR 3 UNIT 416, 417 & 418
LH2 FEED LINE COVER
APS MODULE (2) UNIT 414 UNIT 415
S-IB RETRO ROCKET (4) UNITS 420, 421, 422 & 423
AERODYNAMIC FAIRING

## ABSTRACT

The Narrative End Item Report contained herein is a narrative summary of the Douglas manufacturing and Space Systems Center test records relative to the Saturn S-IVB-210 Flight Stage (Douglas P/N 1A74633-517, S/N 2010).

Narrations are included on those conditions related to permanent nonconformances which were generated during the manufacturing cycle and existed at the time of Space Systems Center acceptance testing. The report sets forth data pertinent to total time or cycle accumulation on time or cycle significant items. Data relative to variations in flight critical components is also included.

## Descriptors

| | |
|---|---|
| NEIR | Significant Items |
| Documentation | Stage Checkout |
| Configuration | Manufacture and Test |

## PREFACE

This Narrative End Item Report is prepared by the Reliability Assurance Operations Department of McDonnell Douglas Corporation, for the National Aeronautics and Space Administration under contract NAS7-101. This report is presented in response to requirements of NPC 200-2, paragraph 14.2.4, and is issued in accordance with Line Item 103 of MSFC-DRL-021, Contract Data Requirements, which details the contract data required from McDonnell Douglas Corporation. The report summarizes the period of initial stage acceptance testing at the Douglas Space Systems Center, Huntington Beach, California, and transfer to Douglas Sacramento Test Center (STC), Sacramento, California.

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APPENDIX I



APPENDIX II



APPENDIX III

## 1.0 INTRODUCTION

### 1.1 Scope

The NEIR compiles quality evidence and assessments of a particular end item for use in evaluating program objectives and end item usage. This report narrates upon the Saturn S-IVB-210 and discusses the following:

a. Configuration at transfer to Sacramento Test Center.

b. Replacements made during Space Systems Center test and acceptance checkout, including the serial number of articles removed or substituted.

c. Nature of problems and malfunctions encountered.

d. Corrective action taken or pending.

e. Extent of retests or tests not completed.

f. Total operating hours or cycles for each time or cycle significant item.

### 1.2 Format

This document is organized into sections, with each section fulfilling a specific purpose. The title of each section and a brief outline of its purpose follow.

SECTION:

1. INTRODUCTION. This section discusses the scope of the NEIR, the Stage Design Concept, and Documentation.

2. NARRATIVE SUMMARY. A brief discussion of the principal test areas is presented to give management personnel a concise view of successful test achievement, and remaining areas of concern.

3. STAGE CONFIGURATION. Conformance to engineering design.

4. NARRATIVE A presentation of checkout operations, presented in the chronological order of testing. Failure and Rejection Reports (FARR's) are referenced as applicable for each paragraph.

5. POSTRETENTION. A presentation of stage configuration, additional stage testing prior to shipment (if any), final inspection, weight and balance, preshipment purge, retest requirements, post-checkout FARR's, and flight critical items installed at shipment.

1.2 (Continued)

APPENDICES.

I. TESTING SEQUENCE. Graphic presentation of the order and activity dates of the VCL checkout procedures.

II. CHARTS. Weld defect charts which show weld discrepancies included in Table I Failure and Rejection Reports.

III. NONCONFORMANCE TABLES.

a. TABLE I. A compilation of FARR's against structural assemblies.

b. TABLE II. A compilation of FARR's recorded during systems installation and checkout.

1.3 Stage Functional Description

A detailed system analysis is beyond the scope of this report The "S-IVB-IB Stage End Item Test Plan", IB66532, contains a description of each operational system, and includes a listing of test procedures, with the objective and prerequisite of each test. Stage 210 is primarily a booster stage, consisting of propellant tanks, feed lines, electrical and pneumatic power for operation of stage systems, and such systems as are required for checkout purposes, fuel loading and unloading control, in-flight control and pressurization, and data measurement during these operations.

1 4 Documentation

Manufacturing and test records for this stage include Fabrication Orders (FO's), Assembly Outlines (AO's), Inspection Item Sheets (IIS's), Failure and Rejection Reports (FARR's) Serial Engineering Orders (SEO's), Radiographic Inspection Records, Hydrostatic test data, Vehicle Checkout Laboratory (VCL) test data, and vendor data. FO's and AO's record in sequence all manufacturing processes, procedures, and Quality Control inspection activities. Any problem or discrepancy noted by Inspection and Test personnel is recorded on an IIS for

1.4 (Continued)

corrective action. Any discrepancy from a drawing requirement is recorded on a FARR by Inspection and Test personnel. The FARR is also used to record the Material Review Board (MRB) disposition applicable to the discrepancy. SEO's may be written to define the rework required by a FARR, to change the effectivity of a drawing; or to change other drawing requirements. Radiographic Inspection Records and X-ray photographs of all weld seams are maintained on file by the contractor. All original data is retained in the contractor's Reliability Assurance Department Central Data Files. Vendor technical data is received on functional purchased parts and also retained in Central Data Files. The majority of documentation referenced within this report is included in the log book which accompanies each stage

## 2.0 NARRATIVE SUMMARY

The following paragraphs present a narrative summary of manufacturing and stage checkout of the S-IVB-210 stage. Stage manufacturing tests and stage checkouts conducted at the Space Systems Center (SSC) are summarized in paragraphs 2.1 and 2.2, respectively, while paragraph 2.3 summarizes the post-checkout propellant tanks leak check Narrations on these tests and operations are presented in section 4

Paragraph 2.4 comments on the preparations for stage retention at Huntington Beach.

### 2.1 Stage Manufacturing Tests

Two major manufacturing tests conducted on the stage during the manufacturing sequence verified the structural integrity of the stage propellant tank assembly. A hydrostatic proof test, started on 11 November and successfully concluded on 12 November 1966, verified that the tank assembly could withstand the required test pressures without leakage or damage The propellant tank leak check, conducted on 16 and 17 November 1966, ensured that there were no leaks in the weld areas nor where the tank assembly wall was penetrated by lockbolts or other fasteners used to attach structural items to the tank assembly.

One minor leak during the hydrostatic proof test, at the $LH_2$ pressure port, was corrected by replacing a cono-seal. No leaks were found during the propellant tank leak check At the conclusion of these tests the tank assembly was accepted for continued manufacturing effort and system installation. A more detailed narration of these tests is presented in paragraph 4 1.

During the normal manufacturing sequence, the tank assembly, P/N 1A39303-525,

2.1 (Continued)

S/N 2010, originally designated for Stage 210, inadvertently had the common bulkhead filled with filtered city water. The resultant rework necessary to ensure a dry, corrosive free atmosphere in the common bulkhead (reference FARR A217183) caused the tank assembly to fall far behind the manufacturing schedule; therefore, tank assembly, P/N 1A39303-529, S/N 2011, was moved forward for installation in Stage 210. This is covered in greater detail in the NEIR concerning Stage 211 (Douglas Report DAC-56563).

## 2.2 Stage Checkout, SSC

The stage was installed in SSC VCL checkout tower 6 on 17 January 1967. Checkout of the stage systems started on 3 February 1967, and was completed on 22 March 1967. However, during this period the stage was removed from the tower for 2 days (22 and 23 February 1967) to remove and replace helium sphere, P/N 1A48858-1, S/N 1157, because it was deformed 0.020 inch. The maximum deformation allowable per Menasco Test Specification was 0.018 inch. Installation of the defective sphere occurred as a result of Menasco Test and Inspection oversight. Work Release Order 3321 authorized the interruption of checkout procedures for the replacement of helium sphere, S/N 1157, by helium sphere, S/N 1134 Serial EO 1A48858-002 was written to also remove helium sphere, S/N 1146, from the stage and replace it with sphere, S/N 1154, while the stage was out of the tower per the WRO. Helium sphere, S/N 1146, was returned to supply. Two days of retest were required to regain checkout status.

2.2 (Continued)

A total of 35 checkout procedures involving the stage systems were accomplished during this period. The stage was removed from the VCL on 27 March 1967, after a total of 34 working days in the tower. Narrations on the checkout procedures are presented in paragraph 4.2, in the order in which the tests were started. Appendix I shows the chronological sequence of the tests, giving the narration paragraph number, the H&CO drawing number and test title, and the dates each test was active.

Prior to turning on the stage power, checks were made of stage wiring continuity and compatibility, the forward and aft skirt thermoconditioning systems, engine alignment, antenna system, cryogenic temperature sensors, hydraulic system fill and bleed, and the umbilical interface wiring. No major problems were encountered during this period, although some FARR's and procedural revisions were written to correct minor problems. The power divider, P/N 1B38999-1, was replaced during the antenna systems test.

Power was first applied to the stage on 9 February 1967, with the initiation of the stage power setup and turnoff procedures. There were no major problems, although minor problems required several procedural revisions. One FARR was written to rework a wire harness for the $LH_2$ tank sensor control unit, P/N 1A68710-509.

The signal conditioning test was satisfactorily completed without problems. The propellant level sensor test was satisfactorily completed, after correcting minor problems. The control units for the LOX tank level sensor L4, P/N 1A68710-511, location 404A63A221, and the $LH_2$ tank level sensor L2,

2.2 (Continued)

P/N 1A68710-509, location 411A61A219, were removed and replaced per two FARR's. The replaced control units were retested and passed satisfactorily.

Activation and completion of the DDAS manual calibration and automatic calibration procedures and the propulsion system control console compatibility procedure were accomplished without the occurrance of major problems. No FARR's were written; however, some procedural revisions were written during operation of the DDAS procedures.

During the automatic DDAS test four FARR's were written, three which rejected measurement transducers for measurements D104, D160, and D208, and one which rejected channel decoder, P/N 1A74053-503. The replacement transducer for measurement D208 was redesignated as measurement D237. All replacement parts were tested and found to be satisfactory.

Leak checks of the propulsion components, the fuel and propellant tanks, the pneumatic control system, the cold helium system, and the J-2 engine were conducted during February and early March 1967. A number of leaks were located and corrected, and several procedural revisions and FARR's were written. During the operation of the fuel tank leak check, a FARR was written to remove and replace the $LH_2$ tank pressurization control module, P/N 1B66230-1. One FARR was written to remove and replace a Voi-Shan seal to correct a leak found during the cold helium leak check. Two FARR's were written during the J-2 engine leak check to correct two leaks by polishing sealing surfaces and replacing seals. The propellant tanks leak check was completed, after a FARR was written to remove the foam and sealant blocking the common bulkhead outlet fitting for measurement D237.

2.2 (Continued)

The propellant utilization system, the exploding bridgewire system, the auxiliary propulsion system, the range safety receiver manual operations and receiver checks, the hydraulic system, and the propulsion system automatic were all completed without the occurrence of major problems. However, there were some procedural revisions written and some program corrections made to the automatic procedures.

The individual system tests were completed by the middle of March 1967, and the all systems test was initiated on 13 March 1967. The umbilicals-in portion of the all systems test required three test runs before it was successfully completed. The problems encountered during the runs were of a minor nature resulting from RFI, EMI, and the loss of the computer during one run The umbilicals-out portion of the all systems test was completed satisfactorily on the first attempt The same RFI and EMI problems were present during this portion of the test. Although the problems encountered during the all systems test were minor, a FARR was written to document the RFI on measurements D7 and D10, because of the out-of-tolerance condition in excess of 2 per cent

The second issue of the forward skirt thermoconditioning system securing procedure was completed on 22 March 1967, following the all system procedure completion. A partial first issue of this procedure had been previously accomplished to prepare the stage for the temporary removal from the tower. There were no problems encountered during the operation of this procedure

## 2.3 Post-Checkout Propellant Tanks Leak Check

Subsequent to VCL checkout, the stage was placed in tower 8 for the propellant tanks system leak test. This was performed on 3 April 1967, to ensure the leak-free condition of the tank assembly. Prior to, but conducted as part

2.3 (Continued)

of the leak test, the setup and hookup test was performed. At the conclusion of the setup and hookup test, the leak test procedure was started. Both procedures were successfully completed without encountering any major problems. However, FARR A228582 was written to correct five leaks that were found. The results of these tests are covered in more detail in paragraph 4.3.

2.4 Stage Retention

At the conclusion of the checkout activities, Stage 210 was prepared for storage at Huntington Beach in building 22 per H&CO 1B67913, Stage Storage Procedure-H.B., as authorized by Work Release Order (WRO) 3453. Those activities occurring during stage storage, and during the subsequent preparations for stage shipment to STC, are covered in section 5.

## 3.0 STAGE CONFIGURATION

The paragraphs of this section define the configuration of the Saturn S-IVB-210 Stage, and note the variations applicable to this stage. Paragraph 3.1 discusses the means used to verify the stage configuration, and paragraph 3.2 contains those variations in stage configuration which represent changes in the scope of the program.

Existing contractural configuration control papers are referenced wherever possible.

### 3.1 Design Intent Verification

The configuration of this stage is defined in the Engineering Configuration List (ECL), Space Vehicle, Model DSV-4B-2-1, Manufacturing Serial Number 2010, dated 3 January 1967. This ECL document includes a listing of all parts, non-hardware drawings, and manufacturing and process specifications required for the manufacture and test of the stage, as defined by Engineering production drawings and EO releases. The ECL has been transmitted to NASA under a separate cover.

Verification of design intent was accomplished by a comparison of the ECL, the Planning Configuration List (PCL), and the Reliability Assurance Department As-Built Configuration List (ABCL). Any discrepancies found were resolved by the contractor, and a listing of the resultant action is filed at the contractor's facility.

### 3.2 Scope Change (SC) and Engineering Change Proposal (ECP) Verification

Scope Changes and Engineering Change proposals, with applicable verification data, are listed in Form DD829-1, which is included in the Stage Log Book. The following paragraphs list those SC/ECP's which were incorporated and verified prior to transfer of the stage to STC. Paragraph 3.2.1 contains the numbers of those SC/ECP's which were incorporated in the initial design of Stage 210. Paragraph 3.2.2 lists and briefly describes those SC/ECP's which were incorporated and verified subsequent to the release of initial stage drawings, but prior to transfer to STC. Those SC/ECP's which are verified at STC, and those which will be incorporated and verified subsequent to stage turnover to NASA, will be described in Volume II.

#### 3 2.1 Scope Changes/Engineering Change Proposals Incorporated in the Initial Design

SC 1016B
SC 1027B
SC 1075B
SC 1096
SC 1104A
SC 1115
SC 1151
SC 1152
SC 1167
SC 1176
SC 1185
SC 1195A
SC 1196
SC 1230
SC 1232A
SC 1266
SC 1278A
SC 1280
SC 1282
SC 1295
SC 1306
SC 1354
SC 1363
SC 1364
SC 1390
SC 1397
ECP X005
ECP X043
ECP X095

3.2.2 Scope Changes/Engineering Change Proposals Incorporated and Verified Prior to Transfer

The following SC/ECP's were incorporated during manufacture and were substantiated as being incorporated by Douglas and AFQA personnel "buy off" of the AO paper. The SC/ECP's are listed as previously complied with (PCW) on form DD829-1.

a. SC 1045B, authorized by CCO 118, provided design specifications for the forward skirt thermoconditioning system.

b. SC 1124, authorized by CCO 259, provided closed loop checkout ability for the stage range safety command RF system.

c. SC 1153A, authorized by CCO's 163 and 280, provided for the redesign of the propellant utilization system, to enable rapid installation of system components under prelaunch conditions at KSC.

d. SC 1187, authorized by CCO's 136, 172, and 330, installed the MSFC furnished control accelerometers and rate gyro.

e. SC 1189, authorized by CCO's 111 and 126, provided for the design, release, and manufacture of the necessary parts and documents for the two-hour and four-and-one-half hour translunar coasts.

f. SC 1193, authorized by CCO 156, provided for the redesign of the LOX tank vent line and supporting hardware.

g. SC 1203, authorized by CCO 168, provided for measurement of the LOX and $LH_2$ turbopumps.

h. SC 1205, authorized by CCO 173, provided for the installation of three additional interface connectors.

i. SC 1207, authorized by CCO's 197, 213, 330, 343, and 414, provided for the modification of the propellant utilization system.

j. SC 1218, authorized by CCO's 202 and 330, provided for a recirculation type chilldown system.

k. SC 1219, authorized by CCO 201, provided for the removal of the telemetering circuit monitoring the APS.

l. SC 1241, authorized by CCO 222, provided an additional sensing element for the engine cutoff circuit.

m. SC 1274, authorized by CCO's 264 and 330, provided short circuit protection for the power supplies.

3.2.2 (Continued)

n. SC 1297A, authorized by CCO's 284 and 330, provided that the forward skirt venting system be modified.

o. SC 1304, authorized by CCO 288, provided for the reduction of $LH_2$ tank pressure, with associated design changes.

p. SC 1326, authorized by CCO's 279 and 595, provided stage and GSE pressure measurements for the recirculation chilldown pumps.

q. SC 1376A, authorized by CCO's 395 and 467, provided for the reduction of trapped propellants at burnout.

r. ECP X021, authorized by CCO 363, provided for static test monitoring of the engine turbopump.

s. ECP X056, authorized by CCO's 413 and 572, provided that consecutive reference designation numbers be assigned to stage relays.

t. ECP X082, authorized by CCO's 434 and 539, provided new engine transducer design requirements.

u. ECP X085, authorized by CCO 444, provided for the redesign of the engine cutoff circuitry.

v. ECP X099, authorized by CCO 461, provided for additional hardwire measurements through the umbilical.

w. ECP X113, authorized by CCO's 472 and 539, provided a method for implementing the secure range safety command system.

x. ECP X114, authorized by CCO 482, provided for independent excitation of power supplies.

y. ECP X124, authorized by CCO's 506, 539, and 562, provided for changes in the stage for Rocketdyne ECP compatibility.

z. ECP X132, authorized by CCO's 383, 422, and 435, provided for redesign of the operational telemetry system.

aa. ECP X134, authorized by CCO's 526, 573, and 636, provided for the redesign of the J-2 engine electrical interface.

ab. ECP X136, authorized by CCO's 329, 538, and 631, provided for the release of a coolant system common to both the S-IB and S-V stages.

ac. ECP X137, authorized by MSFC letter I-V-S-TD-65-53, defined the programmed mixture ratio.

3.2.2 (Continued)

ad. ECP X147, authorized by letter D151, provided for the addition of a relay to the aft 28 vdc power distribution assembly.

ae. ECP X176, authorized by CCO 587, modified the thrust structure.

af. ECP X178, authorized by CCO 597, provided for the release of a stage positive pressure system.

ag. ECP X180, authorized by NASA letters TD 65-48, L740, and L972, specified certain changes to mission control measurements.

ah. ECP X190, authorized by NASA letter I-CO-S-IVB-5-762, provided for rework and redesign of the forward skirt environmental control system.

ai. ECP X196, authorized by CCO 705, provided for rework and redesign of the rate gyro intercostal support.

aj. ECP X198, authorized by CCO's 658 and 692, revised the engine thrust OK circuits.

ak. ECP X209, authorized by CCO 847 and NASA letter L96, revised forward skirt paint requirements.

al. ECP X217, authorized by CCO 698, provided black teflon hoses for the hydraulic system.

am. ECP X224, authorized by CCO 739, provided for RPM measurements for the recirculation chilldown pump.

an. ECP X227, authorized by CCO 704, implemented these measurements changes.

ao. ECP X239, authorized by CCO 729, provided for implementation of the safing engine start circuits.

ap. ECP X255, authorized by NASA letter I-CO-S-IVB-6-130, provided for rework and redesign of the thermal insulation of the Model II switch selectors.

aq. ECP 0355, authorized by make/work (MK/WK), provided for the rework and redesign of the $LH_2$ pressurization diffuser.

ar. ECP 0421, authorized by MK/WK, provided for the addition of measurement K151 to the operational telemetry list.

## 4.0 NARRATIVE - STAGE CHECKOUT

A narration of the stage checkout is presented in this section in the chronological order of testing. The major paragraphs comprising the narrative are: 4.1 Stage Manufacturing Tests; 4.2 Stage Checkout - SSC/VCL; 4.3 Propellant Tanks System Leak Test. These major paragraphs are subdivided to the degree required to present a complete historical record of stage checkout.

Permanent nonconformances and functional failures affecting the stage have been recorded on FARR's, and are referred to by serial number throughout this section (e.g. FARR A217149). The referenced FARR's are presented in numerical order in Table I and Table II of Appendix III.

### 4.1 Stage Manufacturing Tests

During the manufacturing sequence of the stage, two major manufacturing tests were conducted to verify the structural integrity of the stage propellant tanks assembly. These two tests, the hydrostatic proof test and the propellant tanks leak check, are presented in this paragraph. FARR's referenced in this paragraph are presented in Table I of Appendix III.

### 4.1.1 Hydrostatic Proof Test (1B38414 G)

The hydrostatic proof test was conducted on the tank assembly for Stage 210 to ensure the structural integrity of the LOX and $LH_2$ tanks, and to verify that the tank assembly could withstand the required test pressures without leakage or damage. The item subjected to this test was the tank assembly, P/N 1A39303-529, S/N 2011. Tank assembly S/N 2011 was redesignated as S/N 2010 at manufacturing position 31 per WRO 3010, subsequent to this test. The tank assembly was tested without the thrust stucture installation, P/N 1A39312, the sump installation, P/N 1A39154, or the door installation, P/N 1B64441.

Using acceptance test procedure A659-1B38414-PATP14, the hydrostatic proof test was started on 11 November 1966, and was completed on 12 November 1966. The test consisted of varying the water head pressure inside the LOX and $LH_2$ tanks while varying the water in the test tank to equalize the hydrostatic head pressure across the skin of the tank assembly, as required to:

a. Proof the common bulkhead to a positive (internal) pressure differential of 27.5, +0.5, -0.0 psi, and the LOX tank at the common bulkhead joint to 28.7, +0.5, -0.0 psi.

b. Proof the common bulkhead to a negative (external) pressure differential of -20.6, +0.0, -0.5 psi, and the $LH_2$ tank at the common bulkhead joint to 22.5, +0.5, -0.0 psi.

c. Proof the aft LOX tank to a positive (internal) pressure differential of 51.0, +0.5, -0.0 psi, and the common bulkhead at the common bulkhead to aft dome joint to 19.2, +0.5, -0.0 psi.

d. Proof the $LH_2$ tank aft dome to 38.0, +0.5, -0.0 psi, and the common bulkhead at the common bulkhead to aft dome joint to a positive (internal) pressure differential of 5.2, +0.0, -0.5 psi.

Because of the method of performing the test, there is no direct correlation with the specific pressure requirements, but the standpipe levels were those established by Engineering to meet the pressure requirements.

4.1.1 (Continued)

The following standpipe water levels for the appropriate steps of the procedures were: LOX tank, 81.0 feet, common bulkhead positive, 66.2 feet; common bulkhead negative, 51.7 feet; and $LH_2$ tank 87.6 feet. These levels were maintained for 5 minutes, thereby verifying that there was no leakage in the tank assembly. Following completion of the test, the tank assembly was drained, rinsed, and dried in preparation for further manufacturing operations.

No major discrepancies were recorded during the hydrostatic proof test, and no failure and rejection reports were written. The following three revisions were made to the procedure:

a. One revision was written to repair a leak at the $LH_2$ pressure port. The tank was drained, the leak was repaired by replacing a 4.00 inch conoseal, the tank was refilled with 150 inches of water, and the test was resumed.

b. One revision added 2,000 gallons of water and 32 pounds of dichromate, because of a low warning indication.

c. One revision changed a valve indication requirement from closed to open, to correct the procedure.

No modification or rework effort was anticipated that would invalidate the test or require retesting. The hydrostatic proof test was successfully concluded, and the tank assembly was accepted for use.

### 4.1.2 Propellant Tanks Leak Check (1B38414 G)

The propellant tanks leak check verified the integrity of the stage tank assembly, and ensured that no leaks existed in the tank assembly welds, or in areas where the tank wall was penetrated by lockbolts or other fasteners attaching structural items to the tank assembly. The item tested by this procedure was tank assembly, P/N 1A39303-529, S/N 2011. Tank assembly S/N 2011 was redesignated S/N 2010 at manufacturing position 31 per WRO 3010.

The leak check was initiated on 16 November 1966, using test procedure A659-1B38414-1-PATP28, and was completed on 17 November 1966 after two days of activity. There were no parts shortages at the start of the test, and no parts were changed as a result of the test.

The first part of the test was a preliminary leak check of the production test equipment (PTE). The LOX tank was pressurized to 3.5 psig with gaseous nitrogen, and bubble solution was used to check the LOX tank PTE adapters and connectors for leakage. Upon completion of the LOX tank check, the $LH_2$ tank was pressurized to 3.3 psig with gaseous nitrogen, and the $LH_2$ tank PTE adapters and connectors were similarly checked with bubble solution.

A tank assembly integrity test was then started by pressurizing the LOX and $LH_2$ tanks to 12.2 psig each with gaseous nitrogen. The nitrogen supply valves were then closed and the tank pressures were noted. After ten minutes, the tank pressures were measured as 12.2 psig for the LOX tank, and 12.1 psig for the $LH_2$ tank, indicating that there was no major tank leakage. The tanks were then vented to atmosphere until the pressure in each tank was 8.4 psig.

4.1.2 (Continued)

The last phase of the test was a freon injection test. Freon gas was flowed into the tanks at a 20 cubic foot per minute rate until the tank pressures reached 10.2 psig each. The freon system downstream of the evaporator, and from the evaporator to the freon bottles, was then bled to atmosphere. After allowing one hour for freon gas diffusion, bubble solution and a halogen detector were used to leak check the tanks at all weld areas and at all lockbolts or other structural fasteners that penetrated the tank wall. At the conclusion of the freon leak check, the tanks were exhausted to atmosphere, then purged with dry air and recapped to ensure cleanliness.

No discrepancies were noted during this procedure, and no failure and rejection reports were written. Five revisions were made to the procedure for the following:

a. One revision authorized the use of PTE adapters A659-1A57431-PTE1-AD10-10110 and -10050 at port 22, the LOX door, instead of adapters A659-1A57431-PTE4-AD1 and -AD4.

b. One revision added the use of PTE adapters A659-1A57431-PTE4-AD1-161 and -AD4-403 at port 21, the $LH_2$ door adapter.

c. One revision deleted the use of PTE adapters at port 11, the LOX chill return, and port 12, the $LH_2$ chill return, as they were not required on this stage.

d. One revision authorized the use of NAS-625 bolts in lieu of 106265-10A bolts to install the A659-1A57431-PTE-AD10-10110 PTE adapter at port 22, the LOX door.

e. One revision deleted the requirement for submitting completed Quality Engineering Charts (QEC's) to the Structural Design Group.

No modification or rework effort was anticipated that would invalidate this test or require retesting of the tank assembly. At the completion of this test the tank assembly was accepted for further manufacturing operations and equipment installation.

## 4.2 Stage Checkout - SSC/VCL

This paragraph details the tests performed on the stage in the Vehicle Checkout Laboratory at the Douglas Space Systems Center, prior to transfer of the stage for shipment to the Sacramento Test Center. The stage was placed in tower 6 of the VCL on 17 January 1967. System checkouts were initiated on 3 February 1967 and continued until 22 March 1967. Checkout was active on 34 working days during this period. All tests required by the End Item Test Plan, 1B66532-505D, dated 3 February 1967, were activated and completed.

Five interim use parts were installed at the time of the all systems simulated flight test. These were the LOX tank relief valve, P/N 1A49590-513-019, S/N 532, the $LH_2$ tank directional control valve, P/N 1A49988-1-001, S/N 0007, and three Rocketdyne transducers, P/N NA5-27323T3, for measurements C1, C2, and C215. These interim use items were removed prior to stage shipment. The flight use items will be installed for STC prefiring testing.

Paragraphs 4.2.1 through 4.2.35 contain information on the individual tests conducted, and are presented in the order the tests were started.

4.2.1 Continuity Compatibility Check (1B59763 F)

Prior to mating the stage to the VCL electrical support equipment, an end-to-end continuity check was made of all electrical cables and wire harnesses installed on the stage, to ensure the integrity of the stage electrical systems, and to verify that the stage was prepared for the application of electrical power for VCL testing. Where possible, the end-to-end continuity of wire runs was measured through electrical component boxes. The test involved all wire harnesses and electrical wiring installed on the stage.

Initiated on 3 February 1967, the procedure was sufficiently completed by 6 February 1967 to allow stage system testing to begin. Because of some parts shortages, the procedure was held open at that time, and was completed on 9 February 1967, after a total of 6 days of activity. The procedure was certified and accepted on 10 February 1967. Stage wiring continuity was verified by a total of 1994 individual point-to-point resistance measurements, specified in the test procedure by reference item numbers, "from" component, cable, plug, and pin designations, and "to" component, cable, plug, and pin designations. Two of the specified measurements were deleted as noted below. Of the remaining measurements, 1879 were within the original resistance requirement of 1.0 ohm or less. For an additional 74 measurements, readings between 1.0 and 3.0 ohms were acceptable because of the length and type of wire involved. Another 39 measurements were accepted with readings of 50 ± 5 ohms, as these measurements were made through modules containing 49.9 ohm resistors.

Engineering comments to this procedure noted that four items were not installed at the start of the test on 3 February 1967. These units, bus module, P/N's 1B57771-559 and -569 at 441A99A10A21, 404A4A17, 404A4A18, and

4.2.1 (Continued)

404A4A19 were installed and tested prior to the test completion date.

Seven revisions written against the procedure were

a. One revision changed the resistance requirements of 74 measurements to be 1.0 to 3.0 ohms, because of wire lengths and type.

b. One revision changed the resistance requirements of 39 measurements to be 50 ±5 ohms, as the measurements were made through modules containing 49.9 ohm resistors.

c. One revision deleted a measurement that was no longer required due to an orbital coast circuit change.

d. One other revision deleted a revision made in error.

e. Two revisions changed the listed end points of two measurements, one because the procedure listing was in error, and one because the umbilicals were connected, requiring the use of a different end point.

No discrepancies were written against this procedure

No modification or rework effort was anticipated that would invalidate the results of the continuity compatibility check, and the stage electrical wiring was accepted for use.

### 4.2.2 Forward Skirt Thermoconditioning System Checkout Procedure (1B41926 A)

Before automatic checkout activities were started on the stage, the forward skirt thermoconditioning system was functionally checked by this procedure to prepare it for operation and to verify that the system was capable of supporting stage checkout operations. The particular items involved in this test were the forward skirt thermoconditioning system, P/N 1B38426-523, and the GSE Model DSV-4B-359 thermoconditioning servicer, P/N 1A78829-1.

The first issue checkout of the forward skirt thermoconditioning system was started and completed on 6 February 1967. The procedure was certified as acceptable on 8 February 1967. The first issue procedure was run in its entirety without encountering any problems. However, a second issue was necessary because the stage was removed from the tower to replace some helium bottles. The second issue of the procedure was not run in its entirety; therefore, the operation of the first issue will be discussed at length, with a short paragraph covering the portion of the second issue used.

The second issue was initiated, completed, and accepted on 24 February 1967. The second issue was concerned with the equipment setup paragraph, the thermoconditioning system fill paragraph, and the shutdown and securing paragraph. Two revisions were written against the second issue to delete all other paragraphs as they were performed on the first issue and it was not felt necessary to repeat them.

After the preliminary setup of the Model 359 GSE servicer and an inspection of the forward skirt thermoconditioning system for open bolt holes and

4.2.2 (Continued)

properly torqued bolts, the thermoconditioning system was purged with freon gas and then pressurized to 32 ± 1 psig with freon. A system leak check was conducted using a gaseous leak detector, P/N 1B37134-1, set to a sensitivity of 1 on the OZ/YEAR-R12 scale. No leakage was found at any of the system B-nuts and fittings, manifold weld areas, panel inlet and outlet boss welds, or manifold flexible bellows.

The thermoconditioning system was purged with $GN_2$, then water/methanol coolant was circulated through the system. Coolant samples were taken from both the fluid sample pressure valve (system inlet), and the fluid sample return valve (system outlet), and checked for cleanliness, specific gravity, and temperature. The cleanliness analysis showed that no contaminant particles were present in the coolant. The specific gravity at the pressure outlet was 0.901 and at the return outlet was 0.900, at a temperature of 60° F.

A differential pressure test was conducted by measuring the pressure difference between the thermoconditioning system inlet and outlet while a coolant flow rate of 7.8 ± 0.1 gpm was maintained. The coolant temperature was also measured at the system inlet and outlet. Ten measurements, taken at 2 minute intervals, showed that the differential pressure varied from 14.8 psid to 15.1 psid. The supply (inlet) temperature varied from 59.5°F to 62°F, while the return (outlet) temperature varied from 59.5°F to 62°F.

Finally, an air content test was performed by stabilizing the thermoconditioning system coolant static pressure at 20 ± 0.5 psig, and draining sufficient fluid from the system to reduce the static pressure by 15 ± 0.5 psig. The quantity of fluid drained was measured as 12 cc, acceptably less

4.2.2 (Continued)

than the 48 cc maximum permissible quantity for the five cold plate configuration of the thermoconditioning system.

Engineering comments indicated that all parts were installed at the start of the test. No discrepancies or problems were noted during the test. The one revision against the first issue changed the statement requiring 80 day minimum time until recertification, as it was not required. The requirement is that the servicer have a current certification sticker.

The following revisions were made to the second issue:

a. One variation revision was written to connect the servicer supply and return hoses to the stage, to connect the servicer to the stage for thermoconditioning system fill operations.

b. One variation revision deleted all paragraphs of the second issue, except the paragraphs concerned with the equipment setup, the thermoconditioning system fill, and the shutdown and securing. Precheckout was completed; therefore, these paragraphs are the only ones required.

The thermoconditioning system was cycled ten times for a total running time of 3 hours and 4 minutes, during the first issue operation.

During the second issue operation, the thermoconditioning system was cycled three times for a total running time of 2 hours and 5 minutes.

It was not anticipated that this test would be invalidated by any rework or modification, and the forward skirt thermoconditioning system was accepted for use.

### 4.2.3 Forward Skirt Thermoconditioning System Operating Procedure (1B42124 A)

The purpose of forward skirt thermoconditioning system operating procedure was to set up and operate the thermoconditioning servicer, Model DSV-4B-359, P/N 1A78829-1, and supply water/methanol coolant to the thermoconditioning system (TCS), P/N 1B38426, for normal daily operation in the VCL. This procedure was initiated on 7 February 1967.

The system consisted of the tubes, manifolds, plates, and associated hardware required to provide the forward skirt mounted electronic components with a water/methanol heat transfer fluid. The fluid acts as a heat source or heat sink, as necessary.

The test preparation consisted of setting up the servicer, and connecting all hose assemblies; verifying the servicer fluid level; and inspecting the TCS panels, P/N's 1A98132 through 1A98147, for open bolt holes. The fluid temperature control switch was adjusted so that the supply temperature gauge stabilized between 80°F and 90°F. The servicer flow regulator was adjusted until the servicer flowmeter indicated 7.8 ± 0.3 gpm. All lines were checked for leaks. Throughout the course of the automatic acceptance checkout activity, the temperature, the flow rate, supply and return pressures, the $GN_2$ source pressure, the fluid level, and line leakage were monitored every 30 minutes.

Prior to removal of the stage from the VCL tower, to rework the helium spheres, this procedure was used to perform a normal shutdown of the thermoconditioning system in conjunction with portions of the forward skirt thermoconditioning checkout procedure. This procedure was not closed out at that time as it was used to operate the system upon reinstallation of the stage in the VCL tower

4.2.3 (Continued)

for completion of the stage system checkout.

At the conclusion of system checkouts, on 22 March 1967, the system and the servicer were shut down. The shutdown consisted of verifying that the servicer differential pressure was down and that the water/methanol fluid flow rate was approximately zero. The facility valves and circuit breakers were closed and set to off, respectively. Then the shutdown and securing procedure, H&CO 1B62965, was performed.

The time data sheet showed that the system had been cycled 33 times during 345.4 hours of operation. There were no part shortages at the start of the test. No revisions were written against the procedure nor were any FARR's written against the system.

It was noted in the Engineering Comments that a normal shutdown was performed on 22 February 1967, in conjunction with portions of the shutdown and securing H&CO, 1B62965, and the checkout H&CO, 1B41926, to prevent coolant spillage, while the stage was in the horizontal position for helium sphere rework. The system was accepted for use on 22 March 1967.

4.2.4 Engine Alignment Procedure (1B39095 A)

The engine alignment procedure was conducted to verify that the exit plane of the J-2 engine thrust chamber was properly aligned with respect to the S-IVB stage structure. The items involved in this test were the J-2 engine, P/N 103826, S/N J2087; the hydraulic pitch actuator, P/N 1A66248-505, S/N 62; the hydraulic yaw actuator, P/N 1A66248-505, S/N 61; and the stage, P/N 1A74633-517, S/N 2010.

The engine alignment verification was satisfactorily accomplished on 7 March 1967, and was accepted on the same date. A Wild N-3 alignment scope was first used to determine the difference in elevation of datum plane "G" at four locations around the stage periphery. Datum plane "G" was defined as the mating surface between the aft skirt and the handling ring. The elevations at the four locations were determined to be 2.000 in., 2.003 in., 1.980 in., and 1.990 in. The maximum deviation between any two locations was 0.023 in., well within the 0.062 in. maximum deviation limit.

The specified lengths of the pitch and yaw hydraulic actuators were obtained from the Rocketdyne Log Book for the engine, and the actuator lengths were measured by the use of the engine actuator adjustment kit fixture, P/N 1A67441-1. The length of the pitch actuator was measured as 22.993 in, and the yaw actuator was measured as 23.008 in. in length. As both measurements were within the 0.010 in. tolerance of the required lengths of 22.988 and 23.015 in., respectively, it was not necessary to adjust either actuator.

The engine exit plane alignment fixture, P/N 1B54581-1, was positioned and attached to the J-2 engine exit flange, and two clinometers, P/N 1B29613-1,

4.2.4 (Continued)

were positioned on the machined surface block of the fixture. From the clinometer readings, the pitch plane adjusted angle was found to be 0.5 minutes low toward stage position I, and the yaw plane adjusted angle was found to be 2.7 minutes high toward stage position IV. From these measurements, the adjusted exit plane inclination angle was determined to be 2.7 minutes, with the low quadrant between stage positions I and II. This exit plane inclination was well within the maximum inclination limit of 21 minutes.

Engineering comments indicated that all parts were installed at the start of the test. No discrepancies were noted during the test, and no revisions were made to the procedure. No rework or modification was anticipated that would invalidate the results of the test, and the engine alignment was accepted for use.

### 4.2.5 Telemetry and Range Safety Antenna System (1B66927 A)

This test procedure was used to verify the integrity of the telemetry and range safety antenna systems by verifying that the continuities, VSWR's, insertion losses, phasing, and power levels of the system were all within the required limits. In addition, the center frequency and carrier deviation of the PCM/FM transmitter were determined to be correct. The particular items involved in this test included:

| Part Name | Reference Location | P/N | S/N |
|---|---|---|---|
| PCM RF Assembly | 411A64A200 | 1B52721-509 | 35 |
| Bi-Directional Coupler | 411A64A204 | 1A69214-503 | 20011 |
| Coaxial Switch | 411A64A202 | 1A69213-1 | 62 |
| Power Divider | 411A64A201 | 1A69215-501 | 38 |
| Telemetry Antennas | 411E200 & E201 | 1A69206-501 | 68 & 70 |
| Reflected Power Detector | 411MT744 | 1A74776-501 | 2-0185 |
| Forward Power Detector | 411MT728 | 1A74776-503 | 2-0182 |
| Dummy Load | 411A64A203 | 1A84057-1 | 661 |
| Directional Power Divider | 411A97A56 | 1B38999-1 | 19 |
| Hybrid Power Divider | 411A97A34 | 1A74778-501 | 45 |
| Range Safety Antennas | 411E56 & E57 | 1A69207-501 | 37 & 38 |

Initiated on 7 February 1967, the checkout was completed on 15 February 1967, after 4 days of activity. The procedure was certified as acceptable on 15 February 1967.

The tests in this procedure were generally performed by disconnecting various transmission lines in the telemetry and range safety RF systems, and determining insertion losses and VSWR's for various segments of the systems. Measurements of the telemetry system components were made at 258.5 ± 0.1 MHz, and the range safety system components were measured at 450.0 ± 0.1 MHz. A test cable, P/N 1B50922-1, was calibrated for use in the procedure, and found to have a VSWR of 16.0 at 258.5 MHz and 12.0 at 450.0 MHz. The telemetry system insertion loss was measured at the PCM transmitter output, with a 50 ohm load replacing the antenna not under test. The loss to antenna 1 was 5.0 db, and the

4.2.5 (Continued)

loss to antenna 2 was 5.2 db, both within the 6.7 db maximum loss limit. The phasing difference of the two telemetry antenna transmission lines from power divider 411A64A201 to the antennas was found to be 0 degrees, well within the 30 degrees phase difference limit. The VSWR's of the lines from the power divider to the antennas were measured as 1.35 in the antenna 1 line, and 1.48 in the antenna 2 line. Both measurements were within the 1.7 maximum VSWR limit.

The VSWR of the closed loop telemetry system, from the PCM transmitter through the dummy load, was measured as 1.39, meeting the requirement of 1.5 maximum VSWR. The VSWR of the open loop telemetry system, from the transmitter through the antennas, was measured as 1.20, meeting the 1.7 maximum VSWR requirement. The resistances of the range safety system transmission lines were measured from both of the range safety antennas to both of the range safety receivers. Three of these measurements were 0.3 ohm, while the 411W13P1 to 411W19P2 cable measured 0.4 ohm, all meeting the 0.5 ohm maximum requirement. The insulation resistances of the same lines were recorded as infinite, meeting the 100 megohm minimum requirement.

The isolation between the two range safety receivers was measured as 28.0 db, meeting the 25 db minimum requirement. The insertion losses of the range safety antenna system were measured as 5.4 db between receiver 1 and antenna 1; 5.8 db between receiver 1 and antenna 2; 5.6 db between receiver 2 and antenna 1; and 5.4 db between receiver 2 and antenna 2. All of these values met the 6.0 db maximum requirement. The insertion losses of directional power divider 411A97A56 were measured as 24.6 db to receiver 1, and 25.0 db to receiver 2, with both of these meeting the requirement of 24, +1.4, -1.0 db.

4.2.5 (Continued)

The insertion loss of the closed loop checkout cable was measured as 1.3 db, meeting the 1.5 db maximum requirement.

The VSWR's of the lines from the outputs of hybrid power divider 411A97A34 to the range safety antennas were measured as 1.36 to antenna 1, and 1.26 to antenna 2, meeting the requirement of 1.7 maximum VSWR for both cases. The VSWR of the entire range safety antenna system was measured as 1.28 at the input of receiver 1, and as 1.33 at the input of receiver 2, both meeting the requirement of 1.7 maximum VSWR.

The stage power was turned on, and the PCM transmitter center frequency was found to be 258.498 MHz, meeting the tolerance limits of 258.500 ± 0.026 MHz. The transmitter carrier deviation was found to be 39.0 kHz meeting the requirement of 36.0 ± 3.0 kHz. The transmitter output power was measured as 18.2 watts into a test dummy load, exceeding the requirement of 15 watts minimum. The output of forward power detector 411MT728 was measured as 92 millivolts for this power level, meeting the calibration requirement of this unit. For calibration of reflected power detector 411MT744, the forward power detector output was measured as 72 millivolts, giving a forward power of 14.2 watts, while the reflected power was measured as 1.52 watts, meeting the requirement of 11 ± 1 percent of the forward power. The output of the reflected power detector was then measured as 7.6 millivolts, agreeing with the calibration curve for the measured reflected power level.

4.2.5 (Continued)

Engineering comments indicated that all affected parts were installed at the start of the test. Directional power divider 411A97A56, P/N 1B38999-1, S/N 19, was removed by FARR A196154, as noted below. A new power divider, S/N 26, was installed, but failed the isolation test and was removed by FARR A196155, also noted below. Power divider, S/N 19, was reinstalled and satisfactorily passed the test as noted in the above narration. The following failure and rejection reports were written during this procedure:

a. FARR A196154 noted that coaxial connector J6 on power divider 411A97A56, P/N 1B38999-1, S/N 19, was loose on the base. Four screws were tightened to secure J6, and the power divider was accepted for use.

b. FARR A196155 was written against power divider 411A97A56, P/N 1B38999-1, S/N 26, when the isolation between 411W12P1 and 411W13P1 was measured as 21 db instead of the required 25 db minimum. After removal from the stage, retest of the unit did not duplicate the defect, and the unit was accepted for use. As power divider, S/N 19, had been installed, S/N 26 was not reinstalled on Stage 210.

A total of eight revisions were made to the procedure, for the following:

a. One revision added the Stage Power Setup H&CO, 1B59590-1, to the Applicable Documents list, for use during this test.

b. One revision added the Model DSV-4B-267 instrument unit substitute, P/N 1A89817-1, to the End Item Equipment list. The IU substitute was required for sending switch selector commands to the stage.

c. One revision added the switch selector, P/N 50M67864-5, as a cycle significant item.

d. One revision added a requirement that the Douglas Test Conductor and the Customer Representative both approve all revisions generated during the operation of the procedure.

e. Three revisions disconnected the HP5245L frequency counter before making insertion loss measurements, to eliminate loading effects. One of these revisions was incorrectly written, and was deleted by the correctly written third revision.

f. One revision corrected a typographical error to correctly identify cable 411W202.

4.2.5 (Continued)

No modification or retest effort was anticipated that would invalidate this test, and the telemetry and range safety antenna system was accepted for use.

4.2.6 Cryogenic Temperature Sensor Verification (1B59818 D)

The purpose of this procedure was to confirm the calibration and function of each temperature sensor in the stage, of which the normal operating range did not include ambient (room) temperature. The units indicated changes in temperature as the resistance of the sensor changed with changes in temperature in accordance with the Callendar-Van Deusen equation.

The test was begun, completed, and accepted on 24 February 1967. The sensors were tested within the ambient temperature range of 65°F to 70°F. Using the values for resistance at 32°F and sensitivity which were given for each individual sensor, the expected resistance at room temperature for each was calculated. The actual resistance was measured, and compared with the calculated value. The measured resistance was required to be within 5 per cent of calculated resistance, except in the case of sensors, P/N's 1A67862-513, 1B34473-1, and 1A67863-537, which were allowed a 7 per cent tolerance. A tabulation of measured and calculated resistance for each sensor appears in Test Data Table 4.2.6.1.

At the commencement of testing, all parts were installed. No revisions, discrepancies, or functional failures were on record, and the system was deemed acceptable to Engineering.

4.2.6.1 Test Data Table, Cryogenic Temperature Sensor Verification

Cryogenic Temperature Sensor Calculated and Measured Resistance at XX°F

| Part Number | Reference Designation | Serial Number | Calculated Resistance (Ohms) | Measured Resistance (Ohms) | Temp. (°F) |
|---|---|---|---|---|---|
| NA5-27215T5 | 4013MTT17 | | 1355.4 | 1350. | 68 |
| NA5-27215T5 | 4013MTT16 | | 1360.9 | 1343. | 70 |
| 1A67862-505 | 406MT613 | 565 | 1486.4 | 1480. | 67 |
| 1A67862-513 | 408MT612 | 560 | 5363. | 5100. | 65 |
| 1A67863-503 | 405MT605 | 867 | 538.5 | 537. | 67 |
| 1A67863-503 | 425MT600 | 865 | 536.7 | 539. | 65 |
| 1A67863-503 | 405MT612 | 858 | 504.7 | 538. | 69 |
| 1A67863-507 | 403MT652 | 1049 | 1507.8 | 1510. | 67 |
| 1A67863-509 | 410MT603 | 1091 | 1501.6 | 1502. | 66 |
| 1A67863-519 | 424MT613 | 1116 | 215.8 | 216. | 68 |
| 1A67863-519 | 424MT610 | 1128 | 216.7 | 216.3 | 70 |
| 1A67863-535 | 403MT653 | 1072 | 215.4 | 215. | 67 |
| 1A67863-537 | 404MT733 | 1071 | 5363. | 5120. | 65 |
| 1A67863-537 | 404MT685 | 1093 | 5385. | 5143. | 67 |
| 1B34473-1 | 403MT686 | 301 | 5385. | 5130. | 67 |
| 1B34473-501 | 403MT687 | 304 | 1507.8 | 1499. | 67 |
| 1B37878-503 | 409MT653 | 1345 | 1501.6 | 1501. | 65 |
| 1B37878-503 | 409MT652 | 1344 | 1524. | 1500. | 65 |

4.2.7 Hydraulic System Fill, Flush, Bleed and Fluid Samples (1B40973 B)

The purpose of the hydraulic system fill, flush, bleed and fluid sample test was to ensure that the hydraulic system was correctly filled, flushed, bled, and maintained free of contaminants during hydraulic system operation. This procedure also checked the hydraulic pressure and temperature for proper operational levels, the hydraulic system transducers for proper operation, and checked for engine operational clearance in the aft skirt of the stage.

This test procedure was initiated on 8 February 1967, and completed and sold on 22 March 1967. During the 12 days of activity proper operation of the auxiliary hydraulic pump, P/N 1A66241-507, S/N X454601; the hydraulic actuator assemblies, P/N 1A66248-505, S/N's 61 and 62; the engine pump assembly, P/N 1A86847-509, S/N 034; the engine pump, P/N 1A66240-503, S/N MX112311; and the accumulator/reservoir assembly, P/N 1B29319-519, S/N 00024, were verified.

There were no part shortages noted on the Engineering Comments sheet at the beginning of this test.

Before initiation of the test, the hydraulic pumping unit (HPU), P/N 1A67443-1, Model DSV-4B-358 was checked to ensure hydraulic fluid cleanliness. The HPU was then connected to the stage via the pressure and return hoses. Hydraulic fluid was then circulated through the stage hydraulic system to ensure that the system was properly filled, and that the hydraulic fluid passed the cleanliness requirements. Initial electrical stage power setup conditions per 1B59473 were performed to enable a transducer readout of the reservoir when full and empty. This was to further ensure hydraulic system cleanliness and fullness, by cycling the reservoir piston.

4.2.7 (Continued)

Parts of the shutdown portion of this procedure were run out of sequence to disconnect the HPU, because the stage was removed from the VCL checkout tower to rework the helium bottles. When the stage was reinstalled in the VCL checkout tower, the HPU was reconnected to the stage and the procedure was continued from the point of interruption, after ensuring fluid cleanliness.

During the accumulator/reservoir fill and flush portion of the test, a check was made of the accumulator/reservoir low pressure and high pressure relief valves. These measurements are shown in Test Data Table 4.2.7.1.

The accumulator precharge high pressure and relief valve check was performed next. An outside air temperature of 63° F required a precharge pressure of 2350 psig on the accumulator. The accumulator was charged to this pressure, then the system was checked for internal leakage, high pressure relief valve cracking pressure, reservoir pressure, differential pressure, high pressure relief valve reseat pressure, reservoir pressure, and differential pressure. (Differential pressure is the difference of the reservoir pressure from the system pressure.) These measurements are shown in Test Data Table 4.2.7.1.

After connecting the gimbal control unit, P/N 1B50915-1, Model DSV-4B-699, the complete system flush was performed. The gimbal control unit was used to slowly slew the engine in 2 square patterns to the extreme of the actuator travel, while checking complete engine installation for clearance and freedom of motion.

An air content test was performed to ensure that there was a minimum of air in the system; then the hydraulic pressure, temperature, and position transducer operation was performed. The midstroke mechanical locks were installed

4.2.7 (Continued)

and the gimbal control unit was disconnected. The initial electrical conditions were set up per the stage power setup drawing, then, with the accumulator precharged and the auxiliary hydraulic pump/motor off, the measurements in Test Data Table 4.2.7.1 were obtained. The auxiliary hydraulic pump/motor was switched on and run for 1 minute, to obtain measurements.

This test procedure was used throughout the hydraulic system operation to monitor and maintain the hydraulic system in an acceptable condition.

The eight revisions written during the operation of this procedure were:

a. One revision deleted the 1B31356 air pressure transducer because it was not required.

b. One revision required three procedural steps to be effected out of the normal sequence, in order to connect a jumper hose between reservoir air content tester port and the HPU return hose tee coupling valve throughout the test for checkout use.

c. One revision corrected the low pressure relief valve pressure requirement from 275 ± 25 psig to 275 psig maximum to agree with specification control drawing 1A66243.

d. One revision required five steps to be effected out of the normal sequence to permit the stage to be removed from the VCL checkout tower for rework of the helium bottles.

e. One variation revision deleted two steps that required the auxiliary pump motor to be turned on for 5 minutes, then turned off, because the umbilical was not connected to the stage after reinstallation in the VCL checkout tower. The pump motor was run during the hydraulic automatic procedure.

f. One revision changed the paragraph attaching the actuator holding fixture to the stage because it had been redesigned.

g. One revision corrected measurement 1 (5V aft excitation voltage) data select number from 2707 to 1764 to correct the procedure.

4.2.7 (Continued)

h. One revision deleted the step that discontinued the auxiliary pump motor cable from the auxiliary pump motor because it had not been connected (see e. above).

One leak occurred during the leak check, which was corrected by retorquing the B-nut on the pipe assembly, P/N 1B63071-1. The pipe assembly was retested successfully.

There were no modifications or EO's pending that would result in a retest of this procedure. The procedure was signed as acceptable to Engineering for use at the conclusion of this test.

4.2.7.1 Test Data Table, Hydraulic System Fill, Flush, Bleed, and Fluid Samples

Low Pressure Relief Valve

| TEST DESCRIPTION | RECORD | REQUIREMENT |
|---|---|---|
| Low Pressure Relief Valve Relief Pressure (Ground Return) | 248 psig | 275 psig max. |
| Low Pressure Relief Valve Reseat Pressure (Ground Return) | 244 psig | 220 psig min. |
| Low Pressure Relief Valve Relief Pressure (Overboard) | 265 psig | 275 ± 25 psig |
| Low Pressure Relief Valve Reseat (Overboard) | 260 psig | 220 psig min. |
| High Pressure Relief Valve Flow Check: | | |
| System Hydraulic Pressure High | 4310 psig | 4400 psig max. |
| Return Pressure | 260 psig | - |
| Differential Pressure | 4050 psia | 3900 psia min. |

4.2.7.1 (Continued)

## High Pressure Relief Valve

| TEST DESCRIPTION | RECORD | REQUIREMENT |
|---|---|---|
| System Internal Leakage | 0.5 GPM | Less than 0.8 GPM |
| High Pressure Relief Valve Cracking Pressure | 4200 psig | - |
| Reservoir Pressure | 250 psig | - |
| Differential Pressure | 3950 psi | 4100 max. |
| High Pressure Relief Valve Reseat Pressure | 4100 psig | - |
| Reservoir Pressure | 248 psig | - |
| Differential Pressure | 3852 psi | 3760 min. |

## Auxiliary Hydraulic Pump/Motor Off

| Measurement Name | Measurement Data Request Select No. | Recorded Measurements | Measurement Limits |
|---|---|---|---|
| 5V Aft Excitation Module Voltage | 1764 | 5.01 | 5 ± 0.05 vdc |
| Hydraulic System Pressure | 2237 | 1379. | Approximately 1400 psi |
| Hydraulic Pump Inlet Oil Temperature | 1740 | 65.5 | Approximately Ambient Temp. |
| Reservoir Oil Pressure | 2240 | 70.3 | Approximately 80 psi - Must be greater than 55 psi |
| $GN_2$ Accumulator Pressure | 2241 | 2367. | Precharge Pressure Approximately 2350 psia |
| $GN_2$ Accumulator Temperature | 2010 | 66.3 | Approximately Ambient Temp. |
| Reservoir Oil Level | 2627 | 89.7 | Greater than 84.7 per cent |
| Reservoir Oil Temperature | 1741 | 67.8 | Approximately Ambient Temp. |

4.2 7.1 (Continued)

Auxiliary Hydraulic Pump/Motor On

| Measurement Name | Measurement Data Request Select No. | Recorded Measurements | Measurement Limits |
|---|---|---|---|
| 5V Aft Excitation Module Voltage | 1764 | 5.01 | 5 ± 0.05 vdc |
| Hydraulic System Pressure | 2237 | 3582. | 3650 ± 150 psi |
| Hydraulic Pump Inlet Oil Temp. | 1740 | 69.8 | Approximately Ambient Temp. Temp. will climb as running time increases |
| Reservoir Oil Pressure | 2240 | 167.6 | 180 ± 20 psia |
| $GN_2$ Accumulator Pressure | 2241 | 3576. | Hydraulic System Pressure ± 100 psi |
| $GN_2$ Accumulator Temperature | 2010 | 87.4 | Approximately Ambient Temp. Temp. will climb as running time increases |
| Reservoir Oil Level | 2627 | 37.5 | Greater than 25 per cent - Should read approximately 43 per cent |
| Reservoir Oil Temperature | 1741 | 71.4 | Approximately Ambient Temp. - Temp. will climb as running time increases |
| T. M. Pitch Actuator Piston Pot Position | 2521 | 0.008 | ± 0.236 deg. |
| T. M. Yaw Actuator Piston Pot Position | 2534 | 0.002 | ± 0.236 deg. |

### 4.2.8 Aft Skirt and Interstage Thermoconditioning and Purge System (1B40544 NC)

The checkout of the aft skirt and interstage thermoconditioning and purge system was accomplished by this test procedure to verify that the airflow characteristics of the system were correct, and to show that the system could provide the inert environment required in the aft skirt and interstage area during all prelaunch and test firing operations involving the use of $LH_2$. The particular items involved in this test were the aft skirt and interstage thermoconditioning and purge system installation, P/N 1A67979-513, and the GSE Model DSV-4B-651 aft skirt ventilation system kit, P/N 1B38121-1.

This checkout procedure was initiated and completed on 9 February 1967. The procedure was certified as acceptable on 10 February 1967. Pre-operation setup steps were accomplished to prepare the Model 651 ventilation system for use, to connect it to the stage, and to cover and seal open holes in the stage system airflow areas. The stage system tests were conducted by installing various size orifices in the metering duct of the Model 651 aft skirt ventilation system, opening and closing various purge and ventilation holes on the stage, and measuring the Model 651 metering duct pressure difference and the main manifold pressure, while air was blown through the stage system.

For the main manifold leakage and fairing purge test, a 1.4 inch diameter orifice, P/N 1B38983-503, was installed, the main manifold orifices in the station 241 frame and the hydraulic system accumulator reservoir shroud ventilation holes were sealed, and the thrust structure supply duct was clamped. From the measured metering duct orifice pressure difference of 20 inches of water, and the main manifold pressure of 4.3 inches of water, it was determined that the leakage and fairing purge area was 3.28 square inches.

4.2.8 (Continued)

In the thrust structure flow test, a 2.1 inch diameter orifice, P/N 1B38983 -507, and installed, the main manifold orifices in the station 241 frame and the hydraulic system accumulator reservoir shroud ventilation holes were sealed, and the thrust structure supply duct was opened. From the metering duct pressure difference of 20.7 inches of water, and the main manifold pressure of 4.0 inches of water, it was determined that the gross thrust structure purge area was 7.75 square inches. Subtracting the previously determined leakage and fairing purge area, the net thrust structure purge area was 4.47 square inches, well within the 4.1 ± 1.0 square inches requirement.

For the main manifold orifice flow test, a 5.2 inch diameter orifice, P/N 1B38983-511, was installed, all main manifold orifices were opened, the main manifold orifices in the station 241 frame and the hydraulic system accumulator reservoir shroud ventilation holes were opened, and the thrust structure supply duct was clamped. From the metering duct pressure difference of 5.1 inches of water, and the main manifold pressure of 1.5 inches of water, the gross main manifold purge area was found to be 54.0 square inches. Subtracting the leakage and fairing purge area, the net main manifold purge area was 50.72 square inches, well within the 49.0 ± 6.0 square inches requirement.

Engineering comments indicated that there were no part shortages affecting the test. No discrepancies were noted during the test. One revision to the procedure changed the number of orifices used from forty-five to forty-seven, because the additional orifices were needed for the test. No rework or modification was anticipated that would invalidate the results of this test, and the aft skirt and interstage thermoconditioning and purge system was accepted for use.

### 4.2.9 Umbilical Interface Compatibility Check (1B59768 B)

The integrity of the stage umbilical wiring was ensured by this procedure, through verification that the proper loads were present on all power buses, and that the control circuit resistances for propulsion valves and safety items were within the prescribed tolerances. The procedure involved the stage umbilical system electrical wiring and components.

The procedure was initially conducted on 9 February 1967, and was accepted on 10 February 1967. When the stage was reinstalled in the VCL following the helium sphere replacement, the procedure was repeated on a second issue. This was accomplished and accepted on 24 February 1967. The measurement values shown in Test Data Table 4.2.9.1 are those obtained during the second issue of the procedure.

The test consisted of a series of resistance measurements, made at specified test points on the Model DSV-4B-463 signal distribution unit, P/N 1A59949-1, using test point 463A1A5J43-FF as the common test point for all measurements. These measurements verified that all wires and connections were intact and of the proper material and wire gauge, and that all resistance values and loads were within the design requirement limits. The particular test points, circuit functions, measured resistances, and resistance limits are shown in the Test Data Table.

Several problems were encountered during this procedure, although none required failure and rejection report action. During the first performance on 9 February 1967, IIS 277482 noted that plug P32 on cable 404A2W1, P/N 1B54263-1, was miswired. Wire M31S20 was connected to pin S instead of <u>s</u>. The plug was rewired correctly and accepted for use. During the second performance on 24

4.2.9 (Continued)

February 1967, incorrect resistance readings were noted for the bus 4D111, 4D121, and 4D131 regulation measurement circuits. It was determined that the stage electrical system was in the wrong condition for these measurements, as the stage power turnoff procedure was not accomplished before the stage was removed from the VCL for the helium sphere replacement. With GSE patch panels temporarily installed in the signal distribution racks, and the GSE power turned on, commands were sent from the test operator console word simulator panel to place the stage switches in the correct state for the bus 4D111 and 4D121 measurements. The 28 vdc was applied between pin G of connector 411A9J5 and the stage ground, to establish the correct state for the bus 4D131 measurement. With the stage electrical system in the proper condition, the resistance readings were retaken and found to be correct.

Engineering comments indicated that all parts were installed at the start of this procedure. No revisions were written to the procedure. No modification or rework effort was anticipated that would invalidate the results of this test, and the umbilical wiring was accepted for further use.

4.2.9.1 Test Data Table, Umbilical Interface Compatibility Check

Reference Designation 463A2

| Test Point | Umb. Pin | Function | Meas. (Ohms) | Limit (Ohms) |
|---|---|---|---|---|
| A2J29-C | 3 | Cmd., Ambient He. Sphere Dump | 26 | 10 - 60 |
| CB-8-2 | 7 | Cmd., Eng. Ignition Bus Pwr. Off | Inf. | Inf. |
| CB-9-2 | 8 | Cmd., Eng. Ignition Bus Pwr. On | 8 | 5 - 15 |
| CB-10-2 | 9 | Cmd., Eng. Control Bus Pwr. Off | Inf. | Inf. |
| CB-11-2 | 10 | Cmd., Eng. Control Bus Pwr. On | 9 | 5 - 15 |
| A2J29-N | 13 | Cmd., Eng. He. Emer. Vent Control On | 48 | 10 - 60 |
| A2J29-Y | 22 | Cmd., St. Tank Vent Pilot Valve Open | 20 | 10 - 60 |
| CB-4-2 | 25 | Cmd., LOX Tank Cold He. Sphere Dump | 30 | 10 - 60 |
| A2J29-h | 31 | Cmd., Fuel Tank Vent Pilot Valve Open | 48 | 50 max. |
| | | (same, reversed polarity) | Inf. | 500K min. |
| A2J29-i | 32 | Cmd., Fuel Tank Vent Valve Boost Close | 48 | 50 max. |
| | | (same, reversed polarity) | Inf. | 500K min. |
| A2J29-q | 38 | Cmd., Amb. He. Sup. Shutoff Valve Close | 22 | 10 - 60 |
| A2J30-H | 58 | Cmd., Cold He. Sup. Shutoff Valve Close | 1.2K | 1.5K max. |
| | | (same, reversed polarity) | Inf. | Inf. |
| A2J30-W | 10 | Cmd., LOX Vent Valve Open | 47 | 10 - 60 |
| A2J30-X | 11 | Cmd., LOX Vent Valve Close | 47 | 10 - 60 |
| A2J30-Y | 12 | Cmd., LOX and Fuel Prevalve Emerg. Close | 48 | 100 max. |
| | | (same, reversed polarity) | Inf. | Inf. |
| A2J30-Z | 13 | Cmd., LOX and Fuel Chilldown Valve Close | 48 | 10 - 60 |
| A2J30-b | 15 | Cmd., LOX Fill & Drain Valve Boost Close | 21 | 10 - 30 |
| A2J30-c | 16 | Cmd., LOX Fill & Drain Valve Open | 21 | 10 - 30 |
| A2J30-d | 17 | Cmd., Fuel Fill & Drain Valve Boost Close | 21 | 10 - 30 |
| A2J30-e | 18 | Cmd., Fuel Fill & Drain Valve Open | 21 | 10 - 30 |
| A2J42-F | A | Meas., Bus 4D111 Regulation | 115 | 100 - 200 |
| A2J35-y | A | Meas., Bus + 4D141 Regulation | 260 | 50 - 600 |
| A2J6-AA | I | Sup., 28 v + 4D119 Talkback Pwr. | 87 | 60 - 100 |

Reference Designation 463A1

| Test Point | Umb. Pin | Function | Meas. (Ohms) | Limit (Ohms) |
|---|---|---|---|---|
| A5J41-A | A | Meas., Bus + 4D131 Regulation | 1200 | 900 - 1400 |
| A5J41-E | A | Meas., Bus + 4D121 Regulation | 2.1K | 1.6K min. |
| A5J53-AA | I | Sup., 28 v + 4D119 Fwd. Talkback Pwr. | 65 | 60 - 100 |

4.2.10 Stage Power Setup (1B59590 C)

Prior to initiating any other automatic test procedures, the stage power setup procedure verified the capability of the GSE automatic checkout system (ACS) to control power switching to and within the stage, and ensured that the stage forward and aft power distribution system was not subjected to excessive static loads during initial setup sequences. Once the procedure was successfully accomplished, it was used to establish initial conditions during subsequent automatic procedures throughout the VCL testing.

The first attempt, on 9 February 1967, to run the stage power setup test was terminated because the PCM and DDAS ground station could not be synchronized, the $LH_2$ directional control valve was installed in the flight position and required manual positioning to the ground position, and the $LH_2$ fast fill sensor wet condition could not be commanded off.

On 10 February 1967, a second attempt to run the procedure was successful; however, there were some malfunctions. The $LH_2$ fast fill sensor wet condition could not be commanded off. The LOX and $LH_2$ Not Overfill indication did not go off (reference FARR A196151).

The third attempt on 24 February 1967, was successful and there were no malfunctions recorded. The fourth test, run on 14 March 1967, was accepted. The following narration and the measurement values shown in Test Data Table 4.2.10.1 are from this test run.

The test was started by resetting the matrix magnetic relays, and verifying that the corresponding command relays were in the proper state. It was also verified that the umbilical connectors were mated, and that plugs 404W26P1 and 404W27P1 were disconnected from the LOX and $LH_2$ inverters. Then the

4.2.10 (Continued)

4D119 talkback power, the forward power, bus 4D11 power, and bus 4D41 power, were transferred to external power. The sequencer power, engine control bus power, engine ignition bus power, APS bus 1 and bus 2 power, and propulsion level sensor power, were all verified to be OFF. The range safety system 1 and 2 receiver powers and EBW firing unit powers were all transferred to external and verified to be OFF. The switch selector checkout indication enable and the flight measurement indication enable were both turned on.

The bus 4D131 28 vdc power was turned on, and the forward bus 1 initial current and voltage were measured. The range safety safe and arm device was verified to be in the SAFE condition. The engine start pilot relay, the LOX and $LH_2$ chilldown pump pilot relay, the auxiliary hydraulic pump flight mode and coast mode relays, the LOX flight pressure coast period relay, and the EBW ullage rocket relay, were all verified to be reset. The propellant utilization system power and inverter and electronics power, the PCM system group power, and the environmental control group power, were all verified to be OFF.

Next the switch selector functions were turned off for point level sensor arm, engine cutoff, LOX chilldown pump purge dump valve and control valve, engine pump purge control valve enable, RF assembly power, PCM RF assembly power, and the $LH_2$ first burn relay, vent valve, and vent boost close valve. The switch selector $LH_2$ and LOX prevalve and chilldown shutoff valve functions were opened. The switch selector functions were turned off for LOX vent valve and vent boost close valve, rate gyro, accelerometer, and FM/FM system.

4.2.10 (Continued)

The engine cutoff was verified to be OFF, and the forward bus 1 quiescent current was measured. The cold helium supply shutoff valve was closed.

The bus 4D111 28 vdc power was turned on, and the aft bus 1 current and voltage were measured. The sequencer power was turned on, and the RF group power was verified to be OFF. The switch selector PCM system group power function was turned on, and the PCM system group current was measured. The engine gas generator valve, start tank discharge valve, main LOX and $LH_2$ valves, and ASI oxidizer valve, were all verified to be CLOSED, and the engine LOX and $LH_2$ bleed valves were verified to be OPEN.

Then the bus 4D121 28 vdc power was turned on, and the forward bus 2 current and voltage were measured. The prelaunch checkout group power was turned on, and the checkout group current was measured. The RACS run mode was turned on, and the forward and aft battery load tests were turned off. The DDAS ground station source selector switch was manually set to position 1, and the ground station was verified to be in synchronization. The EBW pulse sensor power was turned off. The voltages of the aft, forward 1, and forward 2, 5 volt excitation modules were all measured through the AO and BO telemetry multiplexers.

This completed the stage power setup procedure, and established the initial conditions for other automatic procedures.

The LOX vent valve, P/N 1A49590-513, was not installed at the beginning of this test. This valve was to be installed prior to static firing at STC.

4.2.10 (Continued)

There were three FARR's written during this test run as follows:

a. One FARR, A196152, noted that the insert of the wire harness, P/N 1B54266-1E, 405W1P6, was punctured adjacent to pin B, and that the $LH_2$ tank sensor, P/N 1A68710-509S, S/N D-55 had pin B, in the J-2 plug, bent. The bent pin was straightened per DPS 54002 and was acceptable to Engineering for use. The punctured insert was acceptable to Engineering for use, without rework.

b. One FARR, A196157, noted that one wire of wire harness P/N 1B66496-1B was cracked and damaged. The damaged wire was removed and replaced. The replacement wire was megohmetered and checked for continuity. The rework was acceptable to Engineering for use.

c. One FARR, A196172, was written to cover the damage to pin E of the connector, 404W7P12, that occurred during the rework on wire harness P/N 1B66496-1B, per FARR A196157. The connector, 404W7P12, was removed and replaced. The replacement connector was megohmetered and checked for continuity. The rework was acceptable to Engineering for use.

There were ten revisions written against this procedure, as follows:

a. One revision deleted the digital events recorder (DER) from the Optional End Item list and added it to the Mandatory End Item list, because the DER must be available for system checkout.

b. One revision change the printout and typeout from inverter to inverters to indicate that more than one inverter must be verified.

c. One revision changed two ALCO statements to agree with the test requirements drawing.

d. One revision changed the type statements last word for the forward battery load test off commands from reset to set, because the commands have been set at that point.

e. One revision changed several "Go To" statements to properly index the tables.

f. One revision deleted function number 0264 from Table Buff A and added it to Table Buff D, because the function should be on.

g. One revision added a step to verify or complete Digital Signal Synchronizer switch operation as follows: SERVO to CLOSED, VCO/XTAL to VCO, Data Sample Inversion to UP per NASA letter R-QUAL-P/DAC-#41.

4.2.10 (Continued)

h. Two variation revisions were written to temporarily alter the wire harness clipping for measurements D1, D4, D5, D7, D10, B1 Timing, D18, D55, D255, M69, and M25 to determine if the EMI could be reduced or eliminated.

i. One revision changed the "dummy" curves in the DDT with the actual vendor curves as they were required to checkout the EDS measurements.

It was not anticipated that any modification or rework effort would invalidate the results of this test, and the stage power setup was accepted for use on 22 March 1967.

4.2.10.1 Test Data Table, Stage Power Setup

| Function | Measured Value | Limits |
|---|---|---|
| Forward Bus 1 Initial Current | 0.70 amp. | 20 amp. max. |
| Forward Bus 1 Voltage | 28.16 vdc | 28 $\pm$ 2 vdc |
| Forward Bus 1 Quiescent Current | 0.00 amp. | 5 amp. max. |
| Aft Bus 1 Current | 0.50 amp. | 10 amp. max. |
| Aft Bus 1 Voltage | 28.00 vdc | 28 $\pm$ 2 vdc |
| PCM System Group Current | 4.30 amp. | 8 amp. max. |
| Forward Bus 2 Current | 1.60 amp. | 12 amp. max. |
| Forward Bus 2 Voltage | 27.88 vdc | 28 $\pm$ 2 vdc |
| Prelaunch Checkout Group Current | 0.30 amp. | 12 amp. max. |
| Aft 5 v Excit. Module Voltage, AO | 5.02 vdc | 5.00 $\pm$ 0.05 vdc |
| Aft 5 v Excit. Module Voltage, BO | 5.02 vdc | 5.00 $\pm$ 0.05 vdc |
| Forward 1 5 v Excit. Module Voltage, AO | 4.99 vdc | 5.00 $\pm$ 0.05 vdc |
| Forward 1 5 v Excit. Module Voltage, BO | 4.99 vdc | 5.00 $\pm$ 0.05 vdc |
| Forward 2 5 v Excit. Module Voltage, AO | 4.98 vdc | 5.00 $\pm$ 0.05 vdc |
| Forward 2 5 v Excit. Module Voltage, BO | 4.97 vdc | 5.00 $\pm$ 0.05 vdc |

#### 4.2.11 Stage Power Turnoff (1B59591 D)

The stage power turnoff procedure verifies the capability of the automatic checkout system (ACS) to deactivate stage power. An initial attempt to run the procedure was terminated when the stage power turn on procedure malfunctioned and was terminated. The second attempt, on 15 February 1967, was successfully concluded. At the conclusion of this procedure the stage power distribution system was turned off. Subsequent to verification, the ACS was used to turn off stage power following completion of several procedures.

The power distribution system consists of two forward 28 vdc batteries and one 28 vdc and one 56 vdc aft power supply. Power from these batteries is distributed within the stage by relays. Each distributor unit contains two main busses and a talkback bus. Stage power shutdown involved deactivating all relays so that no current flowed from the batteries through the stage wiring.

It was noted on the Engineering comments log sheet that an interim use part, the LOX vent valve, P/N 1A49590-513-019, S/N 532, was installed on the stage in lieu of the flight critical item, P/N 1A49590-513.

The following three revisions were written against the procedure:

a. One revision deleted the Digital Events Recorder, Model DSV-4B-289 from the list of Optional End Items and added it to the list of Mandatory End Items per NASA request.

b. One revision changed the $LH_2$ and LOX prevalve switch designation from DS1 to DS2 because an OFF channel was to be activated.

c. One revision set-in breakpoints at function numbers 0355, 0726, 0764, 0766, and 0616 per NASA letter R-QUAL-P/DAC-45.

4.2.11 (Continued)

There were no malfunctions noted during testing. There were no modifications or EO's pending that would invalidate the results of this test. The system was signed acceptable for use on 17 February 1967.

### 4.2.12 Signal Conditioning Setup (1B59822 E)

The purposes of this procedure were threefold. It was used to calibrate the 5 and 20 vdc excitation modules, to calibrate signal conditioning equipment, when it was found to be out of tolerance, and to troubleshoot stage instrumentation problems during computer holds.

The signal conditioning equipment included all items required to convert monitored voltages to a form usable by the telemetry system (normally a signal within the range of 0 to 5 vdc). The only parts calibrated in this run were the expanded scale voltage monitor modules, P/N 1A95181-1 and -501, the 5 vdc excitation modules, P/N 1A77310-1, and the 20 vdc 200 ma excitation modules, P/N 1A74036-1.

The 5 vdc excitation modules were calibrated on 10 February 1967. The output from modules 411A99A33, 404A75A7, and 411A98A2 was 5.000 vdc; the design limit was 5.000 ± 0.005 vdc. These measurements were made with an input of 28 ± 0.1 vdc, with potentiometer R23 adjusted to give a -20.000 vdc reading on the Fluke voltmeter, and with a 10 ± 1 vpp at 2000 ± 20 Hz reading at test assembly positions 1 through 4.

The calibration of 20 vdc excitation modules 411A61A242, 404A62A241, 404A63A241, 404A64A241, and 404A63A223 took place on 10 February 1967. Outputs of 19.999 to 20.001 vdc conformed to the 20.000 ± 0.005 vdc output requirement.

On 18 February 1967, the expanded scale voltage monitor modules, P/N 1A95181-1 and -501, were calibrated. With the zero control on the dc amplifier adjusted to a "low" of 0.000 ± 0.005 vdc, and the gain control unit adjusted to a "high" of 4.000 ± 0.005 vdc, the final readings varied from a

4.2.12 (Continued)

low of 0.000 to 0.003 vdc and a high of 4.000 to 4.004 vdc; all within tolerances.

Twenty revisions were written during the procedure run; eight were errors in procedure, one of which superseded two others. The revisions were:

a. One revision added the DSV-4B-267 instrument unit substitute to the end item equipment list.

b. One revision added the switch selector 50M67864-5 as a cycle significant item per NASA memo.

c. One revision deleted reference to certain paragraph numbers in which the Fluke Differential Voltmeter Model 825 is not used.

d. One revision deleted reference to certain paragraphs in which the cables 1B55715-1 and -501 are not used and added a reference to one paragraph in which they are used.

e. Four revisions corrected the list of drawings in the applicable documents.

f. One revision changed the HP205AG generator output millisecond period to allow a closer measurement of the frequency using the period.

g. One revision added a note to Figure 1 to clarify test schematic of 5 volt module.

h. Two revisions corrected tables.

There were no part shortages affecting the test, no functional failures reported, nor was any modification or rework anticipated that would invalidate the test results. The system was accepted for use by Engineering on 21 March 1967.

4.2.13 Level Sensor and Control Unit Calibration (1B59821 E)

This manual procedure determined that the control units associated with the LOX and $LH_2$ liquid level sensors, point level sensors, fast fill sensors, and overfill sensors, were adjusted for an operating point well within the limits of the capacitance change caused by a simulated wet condition of the sensors. The particular items involved in this test were the sensors, P/N 1A68710-1, S/N's D17, D19, D42, D70, D72, D73, D84, D99, D100, and E165, P/N 1A68710-507, S/N's D51, D58, D61, and D63, and the sensors which are an integral part of the LOX mass probe, P/N 1A48430-509-010, S/N D7, and the $LH_2$ mass probe, P/N 1A48431-505, S/N D5; the $LH_2$ sensor control units, P/N 1A68710-509; and the LOX sensor control units, P/N 1A68710-511. The appropriate control unit serial numbers are noted in Test Data Table 4.2.13.1.

Originally initiated on 10 February 1967, the procedure was satisfactorily completed and accepted on 14 February 1967, after 3 days of activity. Following the reinstallation of the stage in the VCL after the helium spheres replacement, a second issue of the procedure was accomplished on 24 and 25 February 1967, and was accepted on 27 February 1967. As noted in the procedure revisions, only the $LH_2$ sensor control units were retested during this second test. The point level sensor manual checkout assembly, P/N 1B50928-1, and a variable precision capacitor, General Radio type 1422 CD, were used during the test to provide capacitance changes to the control units as required to simulate wet conditions, and to determine the control unit operating points.

For each of the control units to be checked, the manual checkout assembly was connected between the sensor and the associated control unit, and the precision capacitor was connected to the checkout assembly to parallel the sensor

4.2.13 (Continued)

capacitance. A voltmeter was connected to the appropriate checkout assembly test points to measure the control unit output signal. To establish the operating point for the control unit under test, the precision capacitor was set for the appropriate calibration capacitance to simulate a wet condition for the associated sensor. These calibration capacitances were 0.7 $\pm$ 0.01 picofarads for all $LH_2$ sensors except the $LH_2$ overfill sensor, which required 1.1 $\pm$ 0.02 picofarads, and 1.5 $\pm$ 0.02 picofarads for all LOX sensors except the LOX overfill sensor, which required 2.1 $\pm$ 0.02 picofarads. The control unit power was then turned on, and the control point adjustment potentiometer (R1) on the unit under test was adjusted until the control unit output signal just changed from 0 $\pm$ 1.1 vdc to 28 $\pm$ 2.0 vdc, indicating activation of the control unit output relay.

The capacitance of the precision capacitor was then decreased until the control unit output signal changed to 0 $\pm$ 1.1 vdc, indicating deactivation of the control unit output relay. The deactivation capacitance value was recorded. The capacitance of the precision capacitor was then increased until the control unit output signal changed to 28 $\pm$ 2.0 vdc, indicating reactivation of the control unit output relay. The reactivation capacitance was also recorded. The recorded capacitance values for each control unit, and the appropriate operating point minimum and maximum capacitance limits, are shown in Test Data Table 4.2.13.1.

Following the capacitance checks, a series of checks on each control unit verified the operation of the output relay. With the associated sensor disconnected, the relay was verified to be deactivated under both normal and test conditions. With the sensor connected, the relay was verified to be deactivated under normal conditions and activated under test conditions.

4.2.13 (Continued)

There were no part shortages at the start of the test, but two control units were removed and replaced during the test by FARR action. Two failure and rejection reports were written during this test:

a. FARR A196152 was written because control unit 411A61A219, P/N 1A68710-509, S/N D71, could not be adjusted for 28 $\pm$ 2.0 vdc. The unit was removed and returned to the vendor for rework. Control unit, P/N 1A68710-509, S/N E105, was installed.

b. FARR A196153 was written because control unit 404A63A221, P/N 1A68710-511, S/N D1, could not be adjusted for 28 $\pm$ 2.0 vdc. The unit was removed and returned to the vendor for rework. Control unit, P/N 1A68710-511, S/N D123, was installed.

Two revisions were made to the procedure:

a. One revision changed the dash numbers of the cables used to connect the manual checkout assembly to the control units and sensors. New cables, P/N's 1B55715-529, 1B54620-503, and 1B54620-505, replaced the previous cables, P/N's 1B55715-525, 1B54620-1, and 1B54620-501. The new cables were six feet long, changed from the previous cable length of two feet.

b. One revision, applicable only to the second issue of the procedure, deleted retesting of the LOX tank sensor control units, as these sensors were not affected by the cold helium sphere replacement in the $LH_2$ tank.

No modification or rework effort was anticipated that would invalidate this test, and the LOX and $LH_2$ level sensors and control units were accepted for use.

## 4.2.13.1 Test Data Table, Level Sensor and Control Unit Calibration

| $LH_2$ Control Units P/N 1A68710-509 | Ref. Loc. 411- | S/N | Deactivation Capacitance (pf) 1st Run | 2nd Run | Minimum | Reactivation Capacitance (pf) 1st Run | 2nd Run | Maximum |
|---|---|---|---|---|---|---|---|---|
| Liq. Level L1 | A61A217 | D70 | 0.666 | 0.669 | 0.5 | 0.669 | 0.671 | 0.9 |
| Liq. Level L2 | A61A219 | E105 | 0.672 | 0.687 | 0.5 | 0.675 | 0.689 | 0.9 |
| Point Level 1 | A92A25 | D67 | 0.688 | 0.684 | 0.5 | 0.700 | 0.685 | 0.9 |
| Point Level 2 | A92A26 | E53 | 0.685 | 0.689 | 0.5 | 0.686 | 0.690 | 0.9 |
| Point Level 3 | A92A27 | D91 | 0.683 | 0.696 | 0.5 | 0.684 | 0.698 | 0.9 |
| Point Level 4 | A61A201 | D88 | 0.669 | 0.694 | 0.5 | 0.682 | 0.698 | 0.9 |
| Fast Fill | A92A43 | D55 | 0.690 | 0.692 | 0.5 | 0.695 | 0.694 | 0.9 |
| Overfill | A92A24 | D66 | 1.060 | 1.082 | 0.9 | 1.080 | 1.084 | 1.3 |

| LOX Control Units P/N 1A68710-511 | Ref. Loc. 404- | S/N | Deactivation Capacitance (pf) 1st Run | Minimum | Reactivation Capacitance (pf) 1st Run | Maximum |
|---|---|---|---|---|---|---|
| Liq. Level L4 | A63A221 | D123 | 1.472 | 1.3 | 1.474 | 1.7 |
| Liq. Level L5 | A63A206 | D83 | 1.460 | 1.3 | 1.468 | 1.7 |
| Point Level 1 | A72A1 | D70 | 1.425 | 1.3 | 1.438 | 1.7 |
| Point Level 2 | A72A2 | D64 | 1.470 | 1.3 | 1.482 | 1.7 |
| Point Level 3 | A72A3 | D69 | 1.482 | 1.3 | 1.484 | 1.7 |
| Point Level 4 | A63A239 | D102 | 1.492 | 1.3 | 1.494 | 1.7 |
| Fast Fill | A72A5 | D36 | 1.439 | 1.3 | 1.443 | 1.7 |
| Overfill | A72A4 | D63 | 2.083 | 1.9 | 2.084 | 2.3 |

### 4.2.14 Digital Data Acquisition System Calibration, Manual Operations (1B59823 F)

Performed in conjunction with the Digital Data Acquisition System Calibration automatic procedure, H&CO 1B59593, this procedure provided the manual operations required to check out the stage digital data acquisition system (DDAS), and to verify the integrity of the system from the data inputs, through the various multiplexers and the PCM/DDAS assembly, to the DDAS ground station. The particular components of the digital data acquisition system involved in this test procedure were the PCM/DDAS assembly 411A97A200, P/N 1A74049-511, S/N 12; the Model 270 time division multiplexers 404A61A200 (CP1-BO), P/N 1B62513-515, S/N 2, and 404A61A201 (DP1-BO), P/N 1B62513-517, S/N 1; the Model 1D remote digital submultiplexer (RDSM) 404A60A200, P/N 1B52894-1, S/N 11; and the Model 102 low level remote analog submultiplexer (RASM) 404A60A201, P/N 1B54062-503, S/N 13.

Initiated on 13 February 1967, this procedure was completed on 14 February 1967. The procedure was certified as acceptable on 16 February 1967. As required by the digital data acquisition system automatic calibration procedure this manual procedure was used to install and remove test cables, make manual adjustments when required, and make some manual test measurements.

The DDAS ground station was verified as being synchronized with the stage DDAS, and the DDAS 72 kHz clock bit rate was measured as 72,006 bits per second, well within the 71,975 to 72,025 bits per second requirement. Test connections were made to the PCM/DDAS assembly to measure the frequency and voltage outputs of the 600 kHz VCO, used to transmit data from the stage DDAS to the DDAS ground station over hardwire circuits. The upper bandedge of the 600 kHz VCO was measured as 641.739 kHz at 3.1 vrms, meeting the requirements of 623.2 to

4.2.14 (Continued)

643.2 kHz at greater than 2.2 vrms, while the lower bandedge was measured as 575.745 kHz at 3.1 vrms, meeting the requirements of 556.8 to 576.8 kHz at greater than 2.2 vrms. The difference between the upper and lower bandedge was 65.994 kHz, well within the acceptable limits of 70 ± 10 kHz.

For testing of the CP1-BO time division multiplexer 404A61A200, the required test cable connections were made and, as required by the automatic calibration procedure, the multiplexer input signal power supply was adjusted to voltage levels of 0.000, 1.250, 2.500, 3.750, and 5.000 vdc, all ± 0.001 vdc, for the five test runs on this multiplexer. During the 0.000 vdc input level test run only, input voltages of 4.5 ± 0.100 vdc and 20.0 ± 1.0 vdc were supplied to the PCM/DDAS assembly 411A97A200. These inputs were 0.0 ± 0.100 vdc and 0.0 ± 1.0 vdc, respectively, during the other four test runs. For testing of the DP1-BO time division multiplexer 404A61A201, the required test cable connections were made and, as required by the automatic calibration procedure, the multiplexer input signal power supply adjustments were repeated for the five test runs on this multiplexer.

For testing of the remote digital submultiplexer 404A60A200, the required test cable connections were made, all RDSM test switches on the RDSM-RASM checkout kit, P/N 1B64402-1, were placed in the OFF position, and the RDSM signal input power supply was adjusted to 20 ± 1 vdc. As required by the automatic calibration procedure for each of the ten test runs on this submultiplexer, nine of the ten RDSM test switches were placed in the OFF position, while one of the test switches was placed in the ON position. Only switch SW1 was ON for run 1, only switch SW2 was ON for run 2, etc. For testing of the remote analog submultiplexer 404A60A201, the required test cable connections were made and,

4.2.14 (Continued)

as required by the automatic calibration procedure, the RASM signal input power supply was adjusted to voltage levels of 0.00, 10.00, 20.00, and 30.00 millivolts dc ± 0.015 millivolts dc each, for the four test runs on this submultiplexer.

For each of the above multiplexer tests, this manual calibration procedure provided only the setup and operating procedures. The results of the tests were not included under the manual procedure, but were a part of the automatic calibration procedure, H&CO 1B59593, and are reported under that procedure in paragraph 4.2.15.

Engineering comments indicated that all parts were installed at the start of the test. One discrepancy was noted during the test. IIS 337319 was written against the PCM/DDAS assembly 411A97A200, P/N 1A74049-511, S/N 12, when the 600 kHz VCO upper bandedge was measured as 641.150 kHz, exceeding the 639.0 kHz maximum limit. The problem was resolved and the IIS was cleared by the procedure revision noted below. No failure and rejection reports were written during this procedure.

One revision was made to the procedure, to agree with MSFC specifications, 50M60067 and 50M66512. The upper and lower bandedge frequencies of the 600 kHz VCO were changed to be 623.2 to 643.2 kHz and 556.8 to 576.8 kHz, respectively. Two paragraphs were also added, requiring that the calculated difference between the measured upper and lower bandedge frequencies be within the limits of 70 ± 10 kHz.

It was not anticipated that any rework or modification would invalidate the results of this test, and the digital data acquisition system was accepted for use.

4.2.15 Digital Data Acquisition System Calibration, Automatic (1B59593 D)

The automatic checkout and calibration of the digital data acquisition system (DDAS) was accomplished by this procedure to verify the integrity of the system, and to show that the system was prepared for operation during stage checkout activities. The DDAS Calibration, Manual Operations, H&CO 1B59823, was performed in conjunction with this automatic procedure to provide the necessary test cable connections and removals, input signal adjustments, and other manual functions. This test involved the following items in particular:

| Part Name | Reference Location | Part Number | S/N |
|---|---|---|---|
| PCM/DDAS Assembly | 411A97A200 | 1A74049-511 | 12 |
| CP1-BO Time Division Multiplexer | 404A61A200 | 1B62513-515 | 2 |
| DP1-BO Time Division Multiplexer | 404A61A201 | 1B62513-517 | 1 |
| Remote Digital Submultiplexer (RDSM) | 404A60A200 | 1B52894-1 | 11 |
| Low Level Remote Analog Submultiplexer (RASM) | 404A60A201 | 1B54062-503 | 13 |

Initiated on 13 February 1967, the procedure was completed on 14 February 1967, and was accepted on 16 February 1967. The automatic test program started by establishing initial conditions for the stage and DDAS. The DDAS 72 kHz bit rate test and 600 kHz VCO test were accomplished by the manual operations procedure, as reported in paragraph 4.2.14. A multiplexer flight calibration test was automatically conducted on the DP1-BO and CP1-BO multiplexers. The outputs of data channels DP1-BO-11-01 through -11-10, and CP1-BO-11-01 through -11-10, were recorded at each of the calibration levels of 0.000, 1.250, 2.500, 3.750, and 5.000 vdc. The output levels of all measured channels were within the ± 0.030 vdc tolerance of the input levels in all cases.

Testing of the CP1-BO and DP1-BO multiplexers was accomplished using the manual operations procedure to make the required test cable connections, and to apply the required input signal levels of 0.000, 1.250, 2.500, 3.750, and 5.000 vdc,

4.2.15 (Continued)

all ± 0.001 vdc, for each run of the multiplexer test. All channel outputs were within the tolerance limit of 0.025 vdc of the applied inputs. Testing of the two remote submultiplexers was also accomplished with the aid of the manual operations procedure. All outputs from these two units were within the required tolerances.

Several problems were encountered during this procedure. A malfunction printout occurred during the 0.000 vdc test of CP1-BO multiplexer channel 9. The program was backed up, and the CP1-BO multiplexer test was satisfactorily accomplished by resetting a malfunction flag to zero. At the completion of the RDSM test, and again at the completion of the RASM test, error printouts occurred during backup attempts. The backups were deleted, and the test continued in both cases. The above problems were initially attributed to a bad tape, but subsequent investigation revealed that a malfunctioning GSE tape unit was at fault. The tape unit was corrected, and no failure and rejection reports were written against the stage equipment.

Engineering comments noted that LOX tank vent and relief valve 424A75A1, P/N 1A49590-513, was not installed at the time of the test. An interim use valve, P/N 1A49590-513-019, was installed in its place. A total of eight revisions were made to the procedure for the following:

a. One revision added the switch selector, P/N 50M67864-5, as a cycle significant item.

b. One revision deleted the Model DSV-4B-289 digital events recorder, P/N 1B39013-1, from the Optional End Item list, while one other revision added the unit to the Mandatory End Item list, in response to a NASA requirement.

c. One revision added the Model DSV-4B-267 instrument unit substitute, and the Model DSV-4B-125 PAM/FM/FM/TM ground station, to the Mandatory End Item list, to comply with Test Requirements Drawing 1B59824F.

4.2.15 (Continued)

d. One revision deleted a step to turn on the bus 4D131 28 volt supply, as the bus was not turned off.

e. One revision added steps to reset a malfunction flag to zero.

f. Two variation revisions deleted backup steps, one because of a parity error, and one because of a run-a-way tape condition. As noted previously, these problems were due to a malfunctioning tape unit.

No modification or rework effort was anticipated that would invalidate this test, and the DDAS was accepted for further use.

4.2.16 Propulsion System Control Console/Stage Compatibility (1B59427 B)

The Model DSV-4B-234 propulsion system control console, P/N 1A65728-1, remotely controlled and monitored the stage propulsion system during automatic and manual checkout operations in the VCL. Prior to using the console, this procedure ensured that the stage-mounted solenoid valves responded properly when the various electrical command switches on the console were operated. The checkout consisted of separate tests on valves in the forward skirt area, the aft skirt area, and the thrust structure area.

The procedure was conducted and accepted on 14 February 1967, without encountering any problems. The proper actuation and deactuation of the solenoid valves was verified by listening for valve actuating at the appropriate modules, and it was verified that the correct indicator lights came on, on the Mainstage Propulsion Manual Control Panel of the control console.

In the forward skirt area, the valves checked were the main vent valve open/close solenoid valve 411A2L1 and boose close solenoid valve 411A2L2; and the main fuel tank bi-directional vent valve flight position solenoid valve 411A30L2 and ground position solenoid valve 411A30L1.

In the aft skirt area, the valves checked were the main fuel tank fill and drain valve open/close solenoid valve 404A44L1 and boost close solenoid valve 404A44L2, the main oxidizer tank fill and drain valve open/close solenoid valve 404A9L1 and boost close solenoid valve 404A9L2; the $LH_2$ and LOX chilldown shutoff valve close/open solenoid valve 404A43L1; and the $LH_2$ and LOX prevalve close/open solenoid valve 404A43L2.

In the thrust structure area, the valves checked were the main oxidizer vent valve open/close solenoid valve 403A75A1L1 and boost close solenoid valve

4.2.16 (Continued)

403A75A1L2, the control helium shutoff valve close/open solenoid valve 403A73A1L2 and the start tank vent valve open/close solenoid valve 403A73A1L2 and the start tank vent valve open/close solenoid valve 403A73A1L1, both in the pneumatic control module, the ambient helium sphere dump valve open/close solenoid valve 403A74A4L1 in the ambient helium fill module, the cold helium dump valve open/close solenoid valve 403A74A2L1 in the cold helium fill module, the cold helium shutoff valve open/close solenoid valves 403A74A1L1 and 493A74A1L3 in the LOX tank pressurization control module, and the engine control bottle vent valve open/close solenoid valve in the engine pneumatic power package. All of the valves responded properly to the signals from the propulsion system control console.

Engineering comments noted that all parts were installed at the start of this test. No revisions to the procedure were written, nor were any problems or malfunctions encountered during procedural operation. As no further modification or rework effort was anticipated that would invalidate the results of this test, the propulsion system control console and the stage-mounted solenoid valves were accepted for use.

#### 4.2.17 Digital Data Acquisition System (1B59594 E)

The digital data acquisition system (DDAS) test provided operational status verification of all data channels on the stage, except certain data channels tested during specific system tests. (The outputs of these channels were checked by the D924A computer and found to be within their specified tolerances.) Proper operation was verified for all signal conditioning units and their associated amplifiers, and for the command calibration channel decoder assembly. The transmitter output and the antenna system were also verified.

This procedure was initiated on 14 February 1967, and was satisfactorily completed on 7 March 1967. Items tested by this procedure consisted of the PCM/DDAS assembly, P/N 1A74049-511, S/N 12, the CP1-BO time division multiplexer, P/N 1B62513-515, S/N 2; the DP1-BO time division multiplexer, P/N 1B62513-517, S/N 1; the remote digital submultiplexer (RDSM), P/N 1B52894-1, S/N 11; and the low level remote analog submultiplexer (RASM), P/N 1B54062-503, S/N 13. Four runs were required before the procedure was satisfactorily completed and sold.

During the first run twenty-four channels printed out as malfunctions. Subsequent troubleshooting revealed that the channel decoder, P/N 1A74053-503, S/N 263, was the cause of fifteen of the channels malfunctioning in the high and low RACS test (reference FARR A196156) It was removed and replaced by channel decoder S/N 328. The transducers for measurements M4 and M23 were adjusted per 1B59822 and checked out ok. The remaining channel malfunctions were corrected by replacing the transducers.

The second run was completed; however, fourteen channels failed. Eight of

4.2.17 (Continued)

the channel failures were caused by operator error. The six remaining channels were corrected after troubleshooting.

The third run was completed after the forward 5 vdc module was adjusted. There were three channel malfunctions on measurements D237, D105, and C1. Measurement C1 had a defective transducer, which was an interim use part; therefore, the measurement requirement was deleted and no action was taken to correct this malfunction. Measurement D105 failed because there was pressure trapped in the line. The pressure was bled off and the measurement was sold manually. Measurement D237 was manually sold after the wire harness was reworked.

The fourth run was successfully completed; however, channel measurements C1 and C4 failed. Measurement C1 was an expected failure (see paragraph above). Measurement C4 was manually sold after bridge module, P/N 1A82274-555, was calibrated per 1B59822. Measurement D577 indicated an out of tolerance condition, which was corrected by bleeding off trapped pressure in the lines, then manually selling the measurement.

When required for special channel checks during the procedure, the GSE telemetry signal distribution unit was manually adjusted to provide calibration signals at frequencies of 100 Hz, 400 Hz, or 1500 Hz. An rms voltmeter and a frequency counter were connected to the appropriate telemetry calibrator panel acoustical output test jacks to measure the voltage and frequency of the calibration signal. These calibration signals were also used to manually check any questionable measurements.

4.2.17 (Continued)

The first portion of the DDAS test was the PCM RF test. This consisted of checking the PCM/DDAS assembly for power output and voltage standing wave ratio, and subjecting the assembly to high and low RACS checks.

Upon completion of the PCM/DDAS assembly test, the program went into the CP1-BO time division multiplexer test, less the special channel test. The CP1-BO multiplexer test consisted of high and low RACS test for voltage indications appropriate to the subchannels tested; ambient output test for psia, on, off, vdc, amps, and degree indications, as appropriate for the subchannel tested; spare channel test for zero voltage or off indication, as appropriate for the subchannel tested; and a reference channel test for zero and full scale indications, as appropriate for the subchannel tested. All CP1-BO multiplexer channels tested showed proper indications, or were corrected and sold manually.

The DP1-BO time division multiplexer test, less the special channel test, was begun after conclusion of the CP1-BO multiplexer test. The DP1-BO multiplexer test was conducted the same as the CP1-BO multiplexer test. All DP1-BO multiplexer channels tested displayed the expected indications, or were corrected and sold manually.

Special channel tests at 400 Hz, 100 Hz and 1500 Hz were performed, in the order given, following completion of the DP1-BO multiplexer tests. The 400 Hz test checked the static inverter-converter, the LOX circulation pump flow rate, and the $LH_2$ circulation pump flow rate. LOX and $LH_2$ flowmeter test at 100 Hz followed the 400 Hz test. The LOX and $LH_2$ pump speeds were checked using the 1500 Hz test input. The indications displayed during the special channel tests were as expected.

4.2.17 (Continued)

Following the conclusion of the special channel tests, the APS simulator multiplexer tests were made. The APS multiplexer tests consisted of high and low RACS tests for proper voltage indications, and of ambient output indications expressed as voltage, psia, and degrees, as appropriate for the channels and subchannels tested.

The final DDAS test performed was the umbilical measurement test, which consisted of the common bulkhead pressure, $LH_2$ ullage pressure, and LOX ullage pressure, all indicated in psia and in voltage reference levels for 20 per cent and 80 per cent. At the conclusion of the umbilical measurement test the DDAS shutdown procedures were initiated by turning on the RACS system run mode, resetting the stimuli conditioner, turning on the flight measurement indicator enable, turning off the engine control bus power, and directing personnel to perform the manual shutdown procedures. The manual shutdown procedures were accomplished by returning the telemetry signal distribution unit and the test operator console to the pre-test configuration, and turning off all power to the test units.

Part shortages in existence at the beginning of the test consisted of the $LH_2$ turbine inlet transducer, measurement C1; the LOX turbine inlet transducer, measurement C2; the LOX turbine outlet transducer, measurement C215; and the LOX tank vent and relief valve, P/N 1A49590-513. No special test was contemplated for these transducers, as they will be installed and tested during the stage prefiring tests at STC. Interim use parts, Rocketdyne P/N's NA5-27323-T3, were installed during this test; however, the requirement for these measurements was deleted as these parts are not flight items. LOX tank vent and relief valve, P/N 1A49590-513-019, S/N 532 was installed as an interim use part for this test.

4.2.17 (Continued)

A detailed analysis of the DDAS automatic test data is beyond the scope of this report.

Four FARR's were written during the operation of this test procedure. The four FARR's were:

a. FARR A196156 rejected decoder assembly, P/N 1A74053-503, S/N 263, because it did not maintain a constant 28 vdc signal output. It was removed and replaced by decoder assembly S/N 328, which tested ok.

b. FARR A196159 rejected transducer P/N 1B39293-1, S/N 17, measurement D160, because the indicated voltage was 0.012 volts out of tolerance. The transducer, S/N 17, was replaced by S/N 80.

c. FARR A196160 reject transducer kit, P/N 1B40242-545, S/N 545-12, measurement D104, because it failed during the Hi and Lo RACS test. Expected Hi RACS voltage was 4.000 ± 0.100 vdc, but the actual voltage received was 0.129 vdc. Expected Lo RACS voltage was 1.000 ± 0.100 vdc, but the actual voltage received was 0.185 vdc. The transducer kit, S/N 545-14, replaced S/N 545-12.

d. FARR A196171 rejected transducer kit, P/N 1B40242-1, S/N 1-5, measurement D208, because it failed to pass the expected output of 14.7 ± 0.5 psia. The output was measured at 15.295 psia. The transducer kit, S/N 1-5, was replaced with transducer kit S/N 1-53. The D208 measurement identification was changed to D237 by revision to correct an error in the procedure.

There were nineteen revisions written against this procedure. The nineteen revisions were:

a. One revision added a step to verify that the T/M antennas were properly connected, as they were used in this test.

b. One revision added a step to hold and verify that the ground station was synchronized. Synchronization verification is required each time transmission mode is changed.

4.2.17 (Continued)

c. One revision opened the tolerance for measurement L007, because only a gross indication is required for this test and the measurement was to be verified in the hydraulic fill, flush, and bleed procedure.

d. One revision added the following GSE to the equipment list, because it was omitted when the procedure was revised:

| Model | P/N | Name |
|---|---|---|
| DSV-4B-321 | 1A68801-1 | Automatic Stage Checkout Pneumatic Console - A3. |
| DSV-4B-726A | 1B55449-1 | Electrical Checkout Adapter Automatic Stage Checkout. |
| DSV-4B-726B | 1B55450-1 | Electrical Checkout Adapter. |
| DSV-4B-321A | 1B44643-1 | Automatic Stage Checkout Pneumatic Console - A45. |
| DSV-4B-726E | 1B55453-1 | Electrical Checkout Adapter. |

e. One revision added the following to the mandatory end item list:

| Model | P/N | Name |
|---|---|---|
| DSV-4B-267 | 1A89817-1 | IU Substitute |
| DSV-4B-289 | 1B39013-1 | Digital Events Recorder |

f. One revision deleted the DSV-4B-289 from the optional end item list as it was a mandatory item.

g. One revision changed the common bulkhead measurement identification from D208 to D237 to conform to the "M" change of 1B43563.

h. Three revisions corrected procedural errors.

i. One revision changed the time delay for the common bulkhead and the ullage pressure transducer circuits from 100 milliseconds to 3 seconds.

j. One revision changed the tolerance of measurement M12 from 1 per cent to 1 1/2 per cent, a more realistic value.

4.2.17 (Continued)

k. One revision added a paragraph reference to statement 4103310 to specify more clearly what is required.

l. One revision changed several ALCO statements to conform to test requirements drawing 1B63164.

m. One variation revision deleted the RACS command for several function numbers, if APS simulators were used.

n. One variation revision was written deleting measurement C4 from the tab run and required that the measurement be made manually, because a connector between the bridge module and the transducer was improperly connected.

o. One variation revision deleted measurement D577 from the tab run and required that the measurement be made manually, because pressure was trapped in the system when this procedure was run.

p. One revision deleted measurement C1 from the tab run as an interim use part was installed in that location.

q. One revision changed the measurement for D577 from 0 $\pm$ 1.0 psia to -0 6 $\pm$ 1.0 vdc, because the measurement must be for zero volts, which is equivalent to -1.6 psia, rather than 0 psia. The vendor curve indicated a 4 per cent minus offset.

There were no modifications or EO's pending that would void or nullify any portion of this test. The digital data acquisition system was accepted for use in the S-IVB stage.

4.2.18 Propulsion Component Internal Leak Check (1B66929 A)

The propulsion component internal leak check was performed to determine reverse seat leakage (if any) of the pneumatic pressurization system check valves. The test was initiated and completed on 14 February 1967.

Stage components tested included pneumatic control system LOX vent and relief valve purge line check valve, P/N 1B51361-1, S/N 225; $LH_2$ fill and drain valve purge line check valve, P/N 1B51361-1, S/N 258; LOX fill and drain valve purge line check valve, P/N 1B51361-1, S/N 223; directional control valve purge line check valve, P/N 1B51361-1, S/N 253; ambient helium fill module pressure supply line check valve, P/N 1B51361-1, S/N 254; two LOX tank pressurization system check valves, P/N's 1B40824-503, S/N's 116 and 184; $LH_2$ tank pressurization system check valve, P/N 1B65673-1A, S/N 19; and the ambient helium fill module, P/N 1A57350-507-002, S/N 0213.

All components tested were installed in the pneumatic control system prior to beginning the test and were reinstalled at the conclusion of the test.

The check valve reverse pressure seat leakage tests were accomplished by connecting a helium source to the outlet of the check valve and attaching a flowmeter to the inlet of the check valve to determine leakage. A flexible hose was connected between a gauge assembly (0 to 5000 psig assembly for all components, except check valve, P/N 1B65673-1, which was tested by use of a 0 to 600 psig assembly), which was connected to the facility helium source, and the component under test. All check valves, except check valve 1B65673-1, were subjected to a regulated helium pressure of 1500 ± 100 psig, for about 1 minute. Maximum allowable leakage was 1 scim. The ambient helium module was tested for internal leakage by connecting a flexible hose

4.2.18 (Continued)

to the outlet of the module and a flowmeter to the inlet of the module. Maximum allowable leakage was 10 scim. The 0 to 5000 psig assembly was removed from the helium source and the 0 to 600 psig assembly installed in its place. A flexible hose was connected between the gauge assembly and check valve, P/N 1B65673-1, at the outlet, with the flowmeter attached to the inlet of the check valve. The check valve was subjected to a regulated helium pressure of 500 ± 25 psig, for about 1 minute. Maximum allowable leakage was 10 scim.

No leakage was recorded. No discrepancies or rejections were written against those components tested nor were any revisions to the procedure written. All components tested by the propulsion component internal leak check procedure successfully passed the test and were accepted for use in the pneumatic pressurization system.

4.2.19 Power Distribution System (1B59592 D)

The automatic checkout of the stage power distribution system verified the capability of the GSE to control power switching to and within the stage, and determined that static loads within the stage were not excessive. The procedure verified that particular stage relays were energized or de-energized as required, and that bi-level talkback indications were received at the GSE. Static loading of the various stage systems or assemblies was determined by measuring the GSE supply current before and after turn-on of the system. All electrical components on the stage were involved in this test, including the point level sensors, the propellant utilization system, the auxiliary propulsion system, the J-2 engine ignition bus, the stage telemetry system, aft bus 2, the LOX and $LH_2$ chilldown inverters, and the external to internal power transfer system.

This procedure was successfully accomplished by the second test run on 15 February 1967, after problems encountered during the first test run were corrected by removing the breakout cables noted below after their use. Following the reinstallation of the stage in the VCL after the helium sphere replacement, a third test run was conducted on 24 February 1967, for Engineering information only. The procedure was accepted on 27 February 1967, on the basis of the second test run, and this test run is covered in the following narration.

The stage power setup procedure was accomplished, and initial conditions were established for the test. The propellant level sensor power was turned on for a point level sensor check. Each of the four $LH_2$ tank point level sensors, and each of the four LOX tank point level sensors, were

4.2.19 (Continued)

checked and found to respond properly within 300 milliseconds when individual simulated wet condition on and off commands were given.

The engine control bus power was turned on, and it was verified that the emergency detection system 2 engine cutoff command would turn the bus power off and prevent it from being turned back on. After this verification, the engine control bus power was again turned on, and the control bus voltage was measured as 27.72 vdc, within the 28 $\pm$ 2 vdc limits. The component test power was turned on, and the voltage was measured as 27.919 vdc, within the 28 $\pm$ 2 vdc limits. The component test power was turned back off, and the voltage was measured as 0.000 vdc, within the 0.0 $\pm$ 1.0 vdc limits.

The simulated wet condition commands were turned on for $LH_2$ tank point level sensors 1, 2, and 3, and LOX tank point level sensors 1, 2, and 3. By turning off the simulated wet condition commands for individual sensors, a series of checks verified that a dry condition indication from any two of these three point level sensors, in either tank, resulted in an engine cut-off signal. For the dry condition of LOX tank point level sensors 1 and 2, the engine cutoff LOX depletion timer showed that the cutoff signal occurred after 0.553 seconds. The engine control bus power, all simulated wet condition commands, and the point level sensor power, were all turned off, completing the point level sensor check.

The PU inverter and electrical power was turned on, the current was measured as 3.9 amperes, less than the 5 amperes maximum limit, and the power was turned off. The APS bus power was turned on, verified as being on, and turned off. The engine ignition bus power was turned on, the bus voltage was measured as 27.69 vdc, within the 28 $\pm$ 2 vdc limit, and the power was

4.2.19 (Continued)

turned off. The PCM RF assembly power was turned on, the current was measured as 5.1 amperes, within the 4.5 ± 3.0 amperes limit, and the PCM/FM transmitter output was verified to be greater than 10 watts. The telemetry RF silence command was turned on, and the PCM RF assembly was verified as being turned off. The RF power output was measured as -0.1 watt, within the limit of 0 ± 2 watts. The PCM RF assembly current was 5.2 amperes with the RF silence command on, within the ± 0.5 ampere tolerance of the previous value. The telemetry RF silence command was turned off, and the PCM RF assembly was verified as again being turned on. The PCM RF output power was measured as 17.22 watts, greater than the 10 watts minimum limit, and the PCM RF assembly power was turned off.

The environmental control group power was turned on, verified as being on, and turned off. The aft bus 2 power was turned on, and the aft bus 2 voltage was measured as 56.24 vdc, within the limits of 56 ± 4 vdc. At this point a manual test setup was made to connect the chilldown simulator cables to LOX chilldown inverter connector 404A74A1J3 and $LH_2$ chilldown inverter connector 404A74A2J3, and to connect breakout box, P/N 1A66386-1, to connector 404A74A2J2 of the $LH_2$ chilldown inverter. The $LH_2$ chilldown pump was turned on, and the aft bus 2 current and the pump current were both measured as 21.40 amperes, within the 22 ± 5 amperes limits The $LH_2$ chilldown inverter frequency was manually measured as 403 Hz, within the 400 ± 4 Hz limits, and four output voltages were measured as 4.286 vdc each, all within the 4.230 ± 0 400 vdc limits The $LH_2$ chilldown pump was turned off, and the $LH_2$ chilldown pump pilot relay reset was verified as being on. The manual test setup was then changed to connect the breakout box to connector 404A74A1J2 of the LOX chilldown inverter

4.2.19 (Continued)

The LOX chilldown pump was turned on, and the aft bus 2 current and the pump current were both measured as 22.00 amperes, also within the 22 ± 5 amperes limits. The LOX chilldown inverter frequency was manually measured as 401 Hz, within the 400 ± 4 Hz limit, and the four output voltages were measured as 4.299 vdc each, all within the 4.230 ± 0.400 vdc limits. The LOX chilldown pump was turned off, and the LOX chilldown pump pilot relay reset was verified as being on. The chilldown pump simulator cables were disconnected from the LOX and $LH_2$ inverters, and the breakout box was disconnected from the LOX inverter.

The rate gyro was turned on, and the gyro heater and sensor power voltages were both manually measured as 27.958 vdc, within the 28 ± 2 vdc limits. The rate gyro was turned back off, and the voltages were verified to be within the 0.0 ± 0.1 vdc limits. The forward bus 1, forward bus 2, and aft bus 1 battery simulators were turned on and measured at 28.12, 28.04, and 27.92 vdc, respectively, all within the 28 ± 2 vdc limits. The aft bus 2 battery simulator was turned on and measured at 55.84 vdc, within the 56 ± 4 vdc limits. The electrical support equipment load banks were checked, with buses 4D20, 4D40, 4D30, and 4D10 measured at 0.04, 0.08, 0.04, and 0.00 vdc, respectively, all within the 0 ± 1 vdc limits. The forward buses were switched to internal power, and forward bus 1 and bus 2 were measured at 28.08 and 28.00 vdc, respectively. Aft bus 1 was switched to internal power, and the bus was measured at 27.92 vdc. Aft bus 1 was returned to external power and measured at 27.88 vdc. All of these measurements were within the 28 ± 2 vdc limits. The aft bus 1 battery simulator was turned off, and the voltage was measured as -0.04 vdc, within the 0 ± 1 vdc limits. Aft bus 2

4.2.19 (Continued)

was switched to internal power and measured at 55.92 vdc, and then returned to external power and measured at 56.00 vdc. Both measurements were within the 56 ± 4 vdc limits. The aft bus 2 battery simulator was turned off, and the voltage was measured as 0.00 vdc, within the 0 ± 1 vdc limits. Forward bus 1 and bus 2 were returned to external power and both were measured at 27.96 vdc, within the 28 ± 2 vdc limits. The forward bus 1 and bus 2 battery simulators were turned off, and the voltages measured as 0.00 and -0.04 vdc, respectively, within the 0 ± 1 vdc limits. The aft bus 2 power supply was turned off, and the voltage was measured as 0.00 vdc, within the 0 ± 1 vdc limits. A number of automatic checks were conducted that satisfactorily verified the proper operation of the switch selector register, the instrument unit 28 v power buses, the range safety receivers, and the EBW firing units. No voltages or currents were measured during these final checks. The computer printout recorded running times of 4 minutes 35.181 seconds for the $LH_2$ chilldown pump, and 1 minute 38.611 seconds for the LOX chilldown pump, during this test run.

Engineering comments noted that an interim use part, LOX tank vent valve, P/N 1A49590-513-019, S/N 532, was installed at reference location 425A75A1. The flight use vent valve was listed as a shortage item. No discrepancies were encountered during this test, and no failure and rejection reports were written. Ten revisions were made to the procedure for the following:

a. One revision added the Model DSV-4B-289 digital events recorder, P/N 1B39013-1, to the Mandatory End Item list, and deleted it from the Optional End Item list, as use of the unit was required during the test.

4.2.19 (Continued)

b. One revision added the range safety receivers, P/N 50M10697, and the range safety control decoders, P/N 50M10698, to the Running Time/Cycle Record list as time significant items, in response to NASA letter I-I/IB-DAC/HB-L516-66.

c. One revision added a breakpoint and a statement to turn on the engine control bus power, to meet test requirements.

d. Three revisions changed five program statements to show the correct status of the non-programmed engine cutoff and the switch selector register reset, to meet test requirements.

e. One revision added breakpoints and 300 millisecond delays at three places in the program, to provide the necessary delay time before "if" statements were started.

f. One revision added the breakpoints and manual setup and operation steps required to make the $LH_2$ and LOX chilldown inverter frequency and voltage checks, per NASA requirements.

g. One revision added steps to turn the rate gyro on and off, and to manually measure the heater and sensor power voltages.

h. One revision changed a preliminary setup requirement to enable the use of the integrated test tape, which was not called out in the release EO.

No modification or rework effort was anticipated that would invalidate this test, and the power distribution system was accepted for further use.

### 4.2.20 Fuel Tank Pressurization System Leak Check (1B59429 B)

The purpose of this manual leak check, begun on 15 February 1967, active for 4 days, with acceptance occuring on 21 March 1967, was to establish the integrity of the $LH_2$ tank pressurization system and hardware.

The system consisted of two pressurization lines, one each from the aft umbilical and the J-2 engine, leading through a control module and thence into the $LH_2$ tank at the forward dome. Also included were tank ullage pressure sensing lines leading to pressure switches and transducers. All of these parts were installed at the time of the test.

The test preparation procedure consisted of first setting up pneumatic GSE sources as follows: manual control to activate; talkback power, pneumatic power, and 5 vdc power on; enable/disable switch to enable; stand selector to stand 1; He and $GN_2$ console supply, as well as all bleed and supply valves closed; all dome vents and gauge isolation valves open; and all dome loaders to stop load. The Model 321 pneumatic console was then pressurized to load stage 1 to 1500 psia, stage 4 to 500 psia, stage 5 to 100 psia, stage 6 to 100 psia, and stage 7 between 40 and 45 psia.

The leak check was initiated by listening for an audible indication of leakage at the $LH_2$ prepress supply valve, then increasing stage 5 line pressure to 300 $\pm$ 20 psia. The aft umbilical to control module line was then leak checked. (The leak check of the J-2 engine to control module line was performed during the J-2 engine system leak check, H&CO 1B59433.) The pressure sensing line to transducer D104 was then checked for leaks, as was the cap assembly connection to the control module. The pressurization line from the control module to the blanking flange was then leak checked.

4.2.20 (Continued)

The pressure switches leak check involved opening the supply valve and listening for an audible indication of gross leakages. The sensing line to transducer D178 was the final part leak checked. The system was then secured.

The leak test record sheet reported on three leaks as follows:

a. The leakage on the upstream side of pipe assembly 1A97404-1B was corrected by replacing the seals and tightening the B nuts to the correct torque value.

b. The leakage on the downstream side of pipe assembly 1A98355-1A was corrected by replacing the seals and tightening the B nuts to the correct torque value.

c. The leakage on the downstream side of pipe assembly 1A98357-1B was corrected by replacing the seals and tightening the B nuts to the correct torque value.

There were three revisions written against this procedure as follows:

a. One revision added instructions to cap pipe assembly 1B63355-1 with suitable protective material to prevent contamination, to correct a procedural omission.

b. One variation revision added the steps necessary to make measurements of the $LH_2$ tank pressurization module check valve reverse seat leakage, because of the dual launch capabilities of this stage.

c. One variation revision provided for a recheck of the $LH_2$ tank pressurization line to ensure a leak free condition at the blanking flange, which was removed for the reverse seat leak check of the $LH_2$ tank pressurization module check valve.

There was one FARR, A196158, written during the operation of this procedure to remove and replace the $LH_2$ tank pressurization control module check valve, P/N 1B55200-505, S/N 1019, because of excessive leakage. The check valve was replaced by check valve, S/N 1031, which was checked out and found to be good.

No modification or EO's were pending that would invalidate the results of this test; therefore, the system was accepted for use.

4.2.21 Propellant Utilization System Calibration (1B59826 F)

This manual calibration procedure verified the operation of the propellant utilization system, and provided the necessary calibration prior to the automatic checkout of the system. For calibration purposes, the Model DSV-4B-248 propellant utilization test set (PUT/S), P/N 1A68014-1, was used to provide varying capacitance inputs to the propellant utilization electronics assembly (PUEA), simulating the LOX and $LH_2$ mass probe outputs under varying propellant load conditions. The particular items involved in this test were static inverter-converter 411A92A7, P/N 1A66212-505.3, S/N 17; propellant utilization electronics assembly 411A92A6, P/N 1A59358-527, S/N 23; LOX mass probe, P/N 1A48430-509-010, S/N D7; and $LH_2$ mass probe, P/N 1A48431-505, S/N D5.

The calibration procedure was initially accomplished and accepted on 15 February 1967. Following the removal and reinstallation of the stage in the VCL tower, the test was reaccomplished by a second issue on 1 March 1967, and was accepted on 2 March 1967. Values shown in this narration are from the second test run. Megohm resistance measurements were made on both the $LH_2$ and LOX mass probes through connector 411W11P1 at PUEA 411A92A6, using a 500 vdc megohmeter. The measured values, shown in Test Data Table 4.2.21.1, were all greater than the 1000 megohm minimum requirement. The output voltages and operating frequency of static inverter-converter 411A92A7 were measured. The resulting values, as shown in the Test Data Table, were all within the required limits.

The PUEA $LH_2$ bridge was calibrated for the empty condition by nulling the PUT/S ratiometer, at a reading of 0.02000, and then nulling the PUEA R2 potentiometer. The PUEA LOX bridge was calibrated for the empty condition

4.2.21 (Continued)

by nulling the PUT/S ratiometer, at a reading of 0.02018, and then nulling the PUEA R1 potentiometer. The PUEA $LH_2$ and LOX bridges were calibrated for the full condition by setting the PUT/S ratiometer to 0.92350, and nulling the $LH_2$ bridge, PUEA R4 potentiometer, and LOX bridge, PUEA R3 potentiometer. Data acquisition was verified by establishing simulated empty and full conditions, and determining the PUT/S ratiometer settings required to null the PUEA $LH_2$ and LOX bridges. The values obtained, as shown in the Test Data Table, were within the required limits. Bridge slew checks were conducted by establishing simulated 1/3 and 2/3 slew conditions, and determining the PUT/S ratiometer settings required to null the PUEA $LH_2$ and LOX bridges for each case. The values obtained, as shown in the Test Data Table, were within the required limits.

Before accomplishing the reference mixture ratio (RMR) calibration, the difference in the previously determined LOX empty and $LH_2$ empty ratiometer readings was found and multiplied by 98.4 vdc to get a V1 reference voltage. As the empty ratiometer readings were the same, the reference voltage was 0.0 vdc. Simulated empty conditions were established, and PUEA residual empty bias potentiometer R6 was nulled. Simulated full conditions were established with the PUT/S C1 capacitor ($LH_2$) set to 187 picofarads, and the PUT/S C2 capacitor (LOX) set to 122 picofarads. The PUEA residual full bias potentiometer R5 was then nulled. $LH_2$ and LOX bridge linearity checks were conducted by adjusting the PUT/S capacitors, C1 for the $LH_2$ test and C2 for the LOX test, to specified values, and determining the PUT/S ratiometer settings required to null the PUEA bridges. As shown in the Test Data Table, the readings obtained were all within the required limits.

4.2.21 (Continued)

The hardwire loading circuits were checked by establishing simulated full conditions and measuring the PUEA $LH_2$ bridge output voltages.

The bridge outputs of 25.57 vdc each were well within the acceptable limits of 25.85 $\pm$ 2.0 vdc. Approximately ten cycles were accumulated on the PUEA cycle significant potentiometers, R1 and R2, during the first run of the procedure, and one additional cycle was accumulated on each potentiometer during the second run.

Engineering comments indicate that all parts were installed at the start of this procedure. The one revision to the procedure added the General Radio 1862C megohmeter or equivalent, and the Hewlet Packard 400H ac voltmeter or equivalent, for use during this test. No discrepancies or problems were encountered during the test. No modification or rework effort was anticipated that would invalidate the results of this procedure, and the propellant utilization system was accepted for further use.

4.2.21.1 Test Data Table, Propellant Utilization System Calibration

$LH_2$ Mass Probe Megohm Check

| | |
|---|---|
| $LH_2$ Probe Elements, pins G to E of 411W11P1: | Inf. megohms |
| 411W11P1 pin G to shield: | Inf. megohms |
| 411W11P1 pin G to stage ground | Inf. megohms |
| 411W11P1 pin G shield to stage ground | Inf. megohms |
| 411W11P1 pin E to stage ground | Inf. megohms |

LOX Mass Probe Megohm Check

| | |
|---|---|
| LOX Probe Elements, pins A to C of 411W11P1: | Inf. megohms |
| 411W11P1 pin C to shield: | Inf. megohms |
| 411W11P1 pin C to stage ground | Inf. megohms |
| 411W11P1 pin A to stage ground | Inf. megohms |

4.2.21.1 (Continued)

Static Inverter-Converter Measurements

| Function | Measured Value | Acceptable Limits |
|---|---|---|
| 5 vdc | 5.04 vdc | 4.50 to 5.10 vdc |
| 21.0 vdc | 21.47 vdc | 20.0 to 22.5 vdc |
| 28.0 vdc | 27.49 vdc | 26 to 30 vdc |
| V/P Excitation | 50.67 vdc | 48 to 51 vdc |
| 115 vrms monitor | 2.71 vdc | 2.28 to 3.18 vdc |
| 117 vdc | 121.15 vdc | 115 to 122.5 vdc |
| TP2 | 21.61 vdc | 20 to 22.5 vdc |
| Frequency | 399.2 Hz | 394 to 406 Hz |

Data Acquisition

| Function | PUT/S Ratiometer | Acceptable Limits |
|---|---|---|
| $LH_2$ Empty | 0.00046 | 0.00000 to 0.00185 |
| LOX Empty | 0.00046 | 0.00000 to 0.00185 |
| $LH_2$ Full | 0.92347 | 0.92165 to 0.92535 |
| LOX Full | 0.92370 | 0.92165 to 0.92535 |

Bridge Slew Checks

| Function | PUT/S Ratiometer | Acceptable Limits |
|---|---|---|
| $LH_2$ 1/3 Slew | 0.32564 | 0.30000 to 0.36000 |
| $LH_2$ 2/3 Slew | 0.63641 | 0.60000 to 0.68000 |
| LOX 1/3 Slew | 0.30840 | 0.30000 to 0.36000 |
| LOX 2/3 Slew | 0.63602 | 0.60000 to 0.68000 |

$LH_2$ Bridge Linearity Check

| PUT/S C1 | PUT/S Ratiometer | Acceptable Limits |
|---|---|---|
| 50 pf | 0.24670 | 0.24508 to 0.24878 |
| 100 pf | 0.49227 | 0.49200 to 0.49570 |
| 150 pf | 0.73931 | 0.73893 to 0.74263 |
| 187 pf | 0.92334 | 0.92165 to 0.92535 |

LOX Bridge Linearity Check

| PUT/S C2 | PUT/S Ratiometer | Acceptable Limits |
|---|---|---|
| 20 pf | 0.15125 | 0.14954 to 0.15324 |
| 50 pf | 0.37762 | 0.37663 to 0.38033 |
| 70 pf | 0.52822 | 0.52700 to 0.53173 |
| 100 pf | 0.75586 | 0.75512 to 0.75882 |
| 122 pf | 0.92360 | 0.92165 to 0.92535 |

### 4.2.22 Propellant Utilization System (1B59481 D)

This automatic checkout procedure verified the ability of the propellant utilization system to determine and control the engine propellant flow mixture ratio to ensure simultaneous propellant depletion, and to provide propellant level information to control the fill and topping valves during LOX and $LH_2$ loading. This test involved all components of the stage propulsion utilization system, including the propellant utilization valve in the J-2 engine, and the following:

| PART | P/N | S/N |
|---|---|---|
| Propellant utilization electronics assembly 411A92A6 | 1A59358-527-011A | 23 |
| Static inverter-converter 411A92A7 | 1A66212-505.3 | 17 |
| LOX mass probe | 1A48430-509-010 | D7 |
| $LH_2$ mass probe | 1A48431-505 | D5 |
| LOX overfill sensor and control unit 404A72A4 | 1A68710-511 | D63 |
| LOX fast fill sensor and control Unit 404A72A5 | 1A68710-511 | D36 |
| $LH_2$ overfill sensor and control unit 411A92A24 | 1A68710-509 | D66 |
| $LH_2$ fast fill sensor and control unit 411A92A43 | 1A68710-509 | D55 |

The first issue release was conducted on 15 February 1967, and signed off on 16 February 1967. It was necessary to run a second issue procedure because the stage was removed from the VCL tower, to rework the helium bottles.

Two runs were required to sell the second issue release. The first run was conducted and completed on 1 March 1967; however, the vellum copies of the revisions were not available for signature at that time. It was, therefore, necessary to make a second run of the second issue. (This second run is identified as run 3, indicating that the system has been operated three times.) The second run of the second issue was conducted, completed, and accepted on 2 March 1967. The operation and test results of the system per this second run are discussed in this paragraph and Test Data Table 4.2.22.1.

4.2.22 (Continued)

After initial conditions were established, ratio values were obtained from the manual Propellant Utilization System Calibration procedure, H&CO 1B59826, and loaded into the computer. From these ratio values, nominal test values were computed for LOX and $LH_2$ coarse mass voltages, fine mass voltages, and loading voltages. The propellant utilization (PU) system power test was conducted first. Power was applied to the PU inverter and electronics, then the forward bus 2 voltage, the static inverter-converter output voltages and operating frequency, and the PU system internal temperature, were all measured. These measurements were all within the required limits.

The servo balance and ratio valve null test was conducted next. The error signal voltage, the ratio valve position voltage, and the LOX and $LH_2$ coarse and fine mass voltages were measured through the AO and BO instrumentation multiplexers. All of these measurements were determined to be within the required limits by the computer.

The PU loading test followed. The GSE loading potentiometer power was turned on, and the voltage measured. Measurements were then made of the LOX and $LH_2$ loading potentiometer sense voltages and signal voltages. Measurements of the LOX and $LH_2$ loading potentiometer signal voltages were repeated after the LOX and $LH_2$ bridge 1/3 checkout relay commands were turned on, and again after these commands were turned off. The GSE power was turned off, and the LOX and $LH_2$ loading potentiometer sense voltages were again measured. All of these measurements were determined to be within the required limits by the computer.

4.2.22 (Continued)

The servo balance bridge gain test was conducted next, starting with a measurement of the error signal voltage. Measurements were made through the AO and BO multiplexers of the ratio valve position voltage and the LOX and $LH_2$ coarse and fine mass voltages. These measurements were repeated with the LOX and $LH_2$ bridge 1/3 checkout relay commands turned on, with the bridge 2/3 checkout relay commands turned on, with the bridge 2/3 checkout relay commands turned off, and with the bridge 1/3 checkout relay commands turned off. The error signal voltage measurement was also repeated under the last condition. All of these measurements were within the required limits.

The next test checked the operation of the overfill and fast fill sensors in the LOX and $LH_2$ tanks by verifying that the proper indicators were registering under ambient (dry) conditions and under simulated wet conditions of the sensors. All four sensors operated satisfactorily.

The PU valve movement tests were conducted next. The ratio valve position voltage was measured through the AO and BO multiplexers at several points in the test, when no valve slew was present. A 50 second plus valve slew test and a 50 second minus valve slew test were accomplished, with the pre-slew system test valve position signal, and the ratio valve position voltages at 3, 5, 8, 20, and 50 seconds measured through the AO multiplexer to determine the changes in the valve position voltage. The tests were then repeated in the reverse order with the voltages measured through the BO multiplexer. All results of these tests were satisfactory.

4.2.22 (Continued)

The last part of this procedure was the PU activate test. All measurements for this test were made through the AO and BO multiplexers. The ratio valve position voltage was measured, then the LOX bridge 1/3 checkout relay command was turned on and the LOX coarse mass voltage was measured. The ratio valve position voltage was remeasured with the PU activate switch turned on, and again with it turned off. The LOX bridge 1/3 checkout relay command was turned off, then the LOX coarse mass voltage and the ratio valve position voltage were remeasured. Similar checks were then made using the $LH_2$ bridge 1/3 checkout relay command. All of these measurements were determined to be within the required limits by the computer.

At the completion of this test run, it was noted that the inverter-converter and PU power had been on 56 minutes 58.351 seconds, that the switch selector was used twenty-three times, and that the LOX and $LH_2$ bridge potentiometers had been cycled two times each.

Engineering comments noted that all parts were installed at the start of this test. Six revisions were made to the procedure for the following:

a. One revision added the Model DSV-4B-289 Digital Events Recorder to the Manditory End Item list and deleted it from the Optional End Item list by request of NASA.

b. One revision corrected the PU ratio valve centering voltage from 2.70 vdc to 2.65 $\pm$ 0.12 vdc.

c. One revision changed the time delay for PU activate from 35 milliseconds to 30 milliseconds to agree with the TR.

d. One variation revision changed the program breakpoint and OSTOL to properly perform the valve movement test.

e. One other variation revision changed a breakpoint and added a 5 second time delay to correct a TR error.

f. One revision deleted the $LH_2$ Boiloff Bias Table requirement as it was not used for this test.

4.2.22 (Continued)

No Failure and Rejection Reports were written against this procedure. No modification or rework effort was anticipated that would invalidate the results of this test, and the propellant utilization system was accepted for use.

### 4.2.22.1 Test Data Table, Propellant Utilization System

Loaded Ratio Values (from H&CO 1B59826)

| | | | |
|---|---|---|---|
| LOX Empty Ratio | 0.000 | LOX 1/3 Bridge Slew Ratio | 0.307 |
| $LH_2$ Empty Ratio | 0.000 | LOX 2/3 Bridge Slew Ratio | 0.636 |
| Residual Bias Empty Voltage | 0.000 | $LH_2$ 1/3 Bridge Slew Ratio | 0.326 |
| | | $LH_2$ 2/3 Bridge Slew Ratio | 0.636 |
| LOX Wiper Ratio | 0.020 | | |
| $LH_2$ Wiper Ratio | 0.020 | | |

Computed Coarse Mass Voltages

| | | | |
|---|---|---|---|
| LOX Empty | 0.000 | $LH_2$ Empty | 0.000 |
| LOX 1/3 Mass | 1.538 | $LH_2$ 1/3 Mass | 1.631 |
| LOX 2/3 Mass | 3.179 | $LH_2$ 2/3 Mass | 3.179 |

Computed Fine Mass Voltages

| | | | |
|---|---|---|---|
| LOX Empty | 1.953 | $LH_2$ Empty | 1.953 |
| LOX 1/3 Mass | 2.144 | $LH_2$ 1/3 Mass | 3.965 |
| LOX 2/3 Mass | 4.302 | $LH_2$ 2/3 Mass | 4.302 |

Computed Loading Voltages

| | | | |
|---|---|---|---|
| LOX Empty | 0.000 | $LH_2$ Empty | 0.000 |
| LOX 1/3 Coarse Mass | 8.613 | $LH_2$ 1/3 Coarse Mass | 9.133 |

PU System Power Test

| FUNCTION | MEASURED VALUE | ACCEPTABLE LIMITS |
|---|---|---|
| Forward Bus 2 Voltage | 28.44 vdc | 28 ± 2 vdc |
| Inverter-Converter 115 vrms | 114.322 vac | 115, +3, -4, vac |
| Inverter-Converter 21 vdc | 21.607 vdc | 21.25 ± 1.25 vdc |
| Inverter-Converter 5 vdc | 5.080 vdc | 5.125 ± 0.325 vdc |
| Inverter-Converter Frequency | 399.367 Hz | 400 ± 6 Hz |
| PU System Internal Temperature | 84.723 deg. | 75 ± 35 deg. |

4.2.22.1 (Continued)

Bridge Balance and Ratio Valve Null Test

| FUNCTION | MEASURED VALUE | AO MULTIPLEXER | BO MULTIPLEXER |
|---|---|---|---|
| Error Signal Voltage | 0.325 vdc | | |
| Ratio Valve Position Voltage | | 2.646 vdc | 2.636 vdc |
| LOX Coarse Mass Voltage | | 0.020 vdc | 0.010 vdc |
| LOX Fine Mass Voltage | | 2.002 vdc | 1.987 vdc |
| $LH_2$ Coarse Mass Voltage | | 0.020 vdc | 0.000 vdc |
| $LH_2$ Fine Mass Voltage | | 2.002 vdc | 1.987 vdc |

PU Loading Test

| FUNCTION | MEASURED VALUE | ACCEPTABLE LIMITS |
|---|---|---|
| GSE Power Supply Voltage | 28.999 vdc | 28 ± 2 vdc |

| Loading Potentiometer Function | LOX Value | $LH_2$ Value |
|---|---|---|
| Sense Voltage, GSE Power On | 28.919 vdc | 28.958 vdc |
| Signal Voltage, Relay Commands Off | 0.000 vdc | 0.000 vdc |
| Signal Voltage, Relay Commands On | 8.395 vdc | 8.887 vdc |
| Signal Voltage, Relay Commands Off | 0.000 vdc | 0.000 vdc |
| Sense Voltage, GSE Power Off | 0.520 vdc | 0.520 vdc |

Servo Balance Bridge Gain Test

| FUNCTION | MEASURED VALUE | AO MULTIPLEXER | BO MULTIPLEXER |
|---|---|---|---|
| Error Signal Voltage | 0.264 vdc | | |
| Ratio Valve Position Voltage | | 2.625 vdc | 2.626 vdc |
| LOX Coarse Mass Voltage | | 0.029 vdc | 0.020 vdc |
| LOX Fine Mass Voltage | | 1.992 vdc | 1.992 vdc |
| $LH_2$ Coarse Mass Voltage | | 0.000 vdc | 0.024 vdc |
| $LH_2$ Fine Mass Voltage | | 2.002 vdc | 1.987 vdc |
| - 1/3 Checkout Relay Commands On - | | | |
| Ratio Valve Position Voltage | | 2.589 vdc | 2.595 vdc |
| LOX Coarse Mass Voltage | | 1.548 vdc | 1.543 vdc |
| LOX Fine Mass Voltage | | 2.295 vdc | 2.290 vdc |
| $LH_2$ Coarse Mass Voltage | | 1.636 vdc | 1.626 vdc |
| $LH_2$ Fine Mass Voltage | | 4.023 vdc | 4.033 vdc |
| - 2/3 Checkout Relay Commands On - | | | |
| Ratio Valve Position Voltage | | 2.574 vdc | 2.559 vdc |
| LOX Coarse Mass Voltage | | 3.188 vdc | 3.184 vdc |
| LOX Fine Mass Voltage | | 4.575 vdc | 4.575 vdc |

4.2.22.1 (Continued)

Servo Balance Bridge Gain Test (Continued)

| FUNCTION | MEASURED VALUE | AO MULTIPLEXER | BO MULTIPLEXER |
|---|---|---|---|
| $LH_2$ Coarse Mass Voltage | | 3.188 vdc | 3.188 vdc |
| $LH_2$ Fine Mass Voltage | | 4.644 vdc | 4.624 vdc |
| - 2/3 Checkout Relay Commands Off - | | | |
| Ratio Valve Position Voltage | | 2.548 vdc | 2.579 vdc |
| LOX Coarse Mass Voltage | | 1.558 vdc | 1.538 vdc |
| LOX Fine Mass Voltage | | 2.285 vdc | 2.285 vdc |
| $LH_2$ Coarse Mass Voltage | | 1.626 vdc | 1.626 vdc |
| $LH_2$ Fine Mass Voltage | | 4.038 vdc | 4.019 vdc |
| - 1/3 Checkout Relay Commands Off - | | | |
| Error Signal Voltage | 0.358 vdc | | |
| Ratio Valve Position Voltage | | 2.625 vdc | 2.620 vdc |
| LOX Coarse Mass Voltage | | 0.000 vdc | 0.005 vdc |
| LOX Fine Mass Voltage | | 1.987 vdc | 1.978 vdc |
| $LH_2$ Coarse Mass Voltage | | 0.010 vdc | 0.000 vdc |
| $LH_2$ Fine Mass Voltage | | 1.987 vdc | 1.987 vdc |

PU Valve Movement Test

| FUNCTION | MEASURED VALUE | ACCEPTABLE LIMITS |
|---|---|---|
| Ratio Valve Position Voltage, AO | 2.641 vdc | 2.53 to 2.77 vdc |
| Ratio Valve Position Voltage, BO | 2.620 vdc | 2.53 to 2.77 vdc |
| 50 Second Plus Valve Slew, AO Multiplexer | | |
| +1 vdc System Test Valve Position Signal | 0.999 vdc | 0.98 to 1.02 vdc |
| V1, Voltage at T+3 Seconds | -0.303 vdc | -0.154 to -0.480 vdc |
| V2, Voltage at T+5 Seconds | -0.405 vdc | -0.201 to -0.559 vdc |
| V3, Voltage at T+8 Seconds | -0.436 vdc | -0.225 to -0.559 vdc |
| V4, Voltage at T+20 Seconds | -0.457 vdc | -0.395 to -0.559 vdc |
| V5, Voltage at T+50 Seconds | -0.451 vdc | -0.395 to -0.559 vdc |
| 50 Second Minus Valve Slew, AO Multiplexer | | |
| Ratio Valve Position Voltage, AO | 2.620 vdc | 2.53 to 2.77 vdc |
| Ratio Valve Position Voltage, BO | 2.625 vdc | 2.53 to 2.77 vdc |
| -1 vdc System Test Valve Position Signal | -0.999 vdc | -0.98 to -1.02 vdc |
| V1, Voltage at T+3 Seconds | 0.303 vdc | 0.154 to 0.480 vdc |
| V2, Voltage at T+5 Seconds | 0.374 vdc | 0.201 to 0.559 vdc |
| V3, Voltage at T+8 Seconds | 0.410 vdc | 0.225 to 0.559 vdc |
| V4, Voltage at T+20 Seconds | 0.426 vdc | 0.395 to 0.559 vdc |
| V5, Voltage at T+50 Seconds | 0.436 vdc | 0.395 to 0.559 vdc |
| 50 Second Minus Valve Slew, BO Multiplexer | | |
| -1 vdc System Test Valve Position Signal | -0.999 vdc | -0.98 to -1.02 vdc |
| V1, Voltage at T+3 Seconds | 0.297 vdc | 0.154 to 0.480 vdc |
| V2, Voltage at T+5 Seconds | 0.364 vdc | 0.201 to 0.559 vdc |
| V3, Voltage at T+8 Seconds | 0.410 vdc | 0.225 to 0.559 vdc |
| V4, Voltage at T+20 Seconds | 0.431 vdc | 0.395 to 0.559 vdc |

4.2.22.1 (Continued)

PU Valve Movement Test (Continued)

| FUNCTION | MEASURED VALUE | ACCEPTABLE LIMITS |
|---|---|---|
| V5, Voltage at T+50 Seconds | 0.426 vdc | 0.395 to 0.559 vdc |
| Ratio Valve Position Voltage, AO | 2.620 vdc | 2.53 to 2.77 vdc |
| Ratio Valve Position Voltage, BO | 2.625 vdc | 2.53 to 2.77 vdc |
| 50 Second Plus Valve Slew, BO Multiplexer | | |
| +1 vdc System Test Valve Position Signal | 0.989 vdc | 0.98 to 1.02 vdc |
| V1, Voltage at T+3 Seconds | -0.328 vdc | -0.154 to -0.480 vdc |
| V2, Voltage at T+5 Seconds | -0.405 vdc | -0.201 to -0.559 vdc |
| V3, Voltage at T+8 Seconds | -0.436 vdc | -0.225 to -0.559 vdc |
| V4, Voltage at T+20 Seconds | -0.457 vdc | -0.395 to -0.559 vdc |
| V5, Voltage at T+50 Seconds | -0.462 vdc | -0.395 to -0.559 vdc |

PU Activate Test

| FUNCTION | AO MULTIPLEXER | BO MULTIPLEXER |
|---|---|---|
| Ratio Valve Position Voltage | 2.636 vdc | 2.646 vdc |
| LOX Coarse Mass Volt., Relay Command On | 1.558 vdc | 1.543 vdc |
| Ratio Valve Position, PU Activate On | 0.112 vdc | 0.107 vdc |
| Ratio Valve Position, PU Activate Off | 2.604 vdc | 2.600 vdc |
| LOX Coarse Mass, Relay Command Off | 0.010 vdc | 0.000 vdc |
| Ratio Valve Position Voltage | 2.625 vdc | 2.625 vdc |
| $LH_2$ Relay Command On Ratio Valve Position, PU Activate On | 4.656 vdc | 4.641 vdc |
| Ratio Valve Position, PU Activate Off | 2.620 vdc | - |
| LOX Coarse Mass Voltage, Relay Command Reset | 0.005 vdc | 0.005 vdc |
| Ratio Valve Position Voltage | 2.636 vdc | - |

### 4.2.23 Auxiliary Propulsion System (1B59601 D)

As flight APS modules were not installed during VCL testing, this automatic checkout, using the Model DSV-4B-188 APS simulator, verified the integrity of the stage wiring associated with APS functions, and verified the correct receipt of command signals routed from the GSE automatic checkout system, through the attitude control relay packages, to the APS electrical interfaces. The Model DSV-4B-188 did not simulate the APS modules functionally, but provided suitable loads at the electrical interface to determine that stage mounted components of the APS functioned properly. This test involved all stage mounted components of the auxiliary propulsion system, in particular the attitude control relay packages, P/N 1B57731-1, (50M35076-1), S/N 346, at reference location 404A71A19, and S/N 347, at reference location 404A75A18.

This procedure was accomplished and accepted on 15 February 1967. Initial conditions were established for the test. The GSE instrument substitute -28 vdc power supply was turned on and measured as -29.36 vdc, within the -28 ± 2 vdc limit. The APS firing enable command, and the APS bus power were turned on. A series of tests were conducted to verify the proper operation of the APS engine valve solenoids. Attitude control nozzle commands were turned on and the appropriate APS engine valve open indication voltage was measured through the AO and BO instrumentation multiplexers. The attitude control nozzle command was then turned off, and the valve open indication voltage was again measured. As shown in Test Data Table 4.2.23.1, the results of these tests were all acceptable. After the satisfactory conclusion of these tests, the GSE instrument unit substitute -28 vdc power, the APS firing enable command, and the APS bus power were turned off, completing the test procedure.

4.2.23 (Continued)

Engineering comments indicated that all parts were installed at the start of the test. One revision written against the procedure deleted the Model DSV-4B-289 digital events recorded from the Optional End Item list and entered it in the Manditory End Item list. No discrepancies were noted during the test, and no failure and rejection reports were written against the procedure. No modification or rework effort was anticipated that would invalidate the results of this test, and the stage mounted components of the auxiliary propulsion system were accepted for use.

### 4.2.23.1 Test Data Table, Auxiliary Propulsion System

| Attitude Control Nozzle Command | | APS Engine | Valve Open Indication Voltage (vdc) AO Multiplexer | BO Multiplexer | Limits |
|---|---|---|---|---|---|
| + Z + Y | ON | 1-1 or 1-3 | 4.12 | 4.13 | 4.3 ± 0.25 |
| | OFF | 1-1 or 1-3 | -0.01 | 0.00 | 0.0 ± 0.25 |
| + Z - Y | ON | 1-1 or 1-3 | 4.14 | 4.14 | 4.3 ± 0.25 |
| | OFF | 1-1 or 1-3 | -0.01 | 0.00 | 0.0 ± 0.25 |
| + Z P | ON | 1-2 | 4.16 | 4.18 | 4.3 ± 0.25 |
| | OFF | 1-2 | -0.01 | 0.00 | 0.0 ± 0.25 |
| - Z - Y | ON | 2-1 or 2-3 | 4.03 | 4.04 | 4.1 ± 0.25 |
| | OFF | 2-1 or 2-3 | -0.00 | 0.00 | 0.0 ± 0.25 |
| - Z + Y | ON | 2-1 or 2-3 | 4.01 | 4.01 | 4.1 ± 0.25 |
| | OFF | 2-1 or 2-3 | -0.01 | -0.00 | 0.0 ± 0.25 |
| - Z P | ON | 2-2 | 4.08 | 4.09 | 4.1 ± 0.25 |
| | OFF | 2-2 | -0.00 | 0.00 | 0.0 ± 0.25 |

4.2.24 <u>Exploding Bridgewire System (1B59597 D)</u>

The exploding bridgewire system test verified the integrity of the EBW system, and showed that the system was capable of initiating ullage rocket ignition and jettison when commanded by the instrument unit (IU) during stage operation. The particular items checked by this procedure were the ullage rocket ignition and jettison EBW firing units, P/N 40M39515-113, S/N's 236 and 237, and P/N 40M39515-119, S/N's 432, 433, 440, 449, 458, and 460.

This automatic test procedure was initially conducted on 15 February 1967, and was accepted on 16 February 1967. Following the reinstallation of the stage in the VCL after the helium sphere replacement, the procedure was reaccomplished by a second issue on 24 February 1967. The second test was accepted on 27 February 1967. The following narration covers the second issue of this procedure.

The stage power setup procedure was accomplished, and initial conditions were established for the test. The EBW pulse sensor power was turned on, and the eight EBW pulse sensors were verified to be reset. A pulse sensor self test, and pulse sensor on and reset checks, verified that the pulse sensors were all operating properly. During the subsequent firing unit checks, the firing unit indication voltages were measured through the AO and BO multiplexers.

The charge ullage ignition command was turned on, and it was verified that the six ullage ignition firing units charged properly, while the two ullage jettison firing units remained uncharged. The ignition firing unit indication voltages were measured between 4.20 and 4.28 vdc, within the 4.2 $\pm$ 0.3 vdc limits. The jettison firing unit indication voltages were measured

4.2.24 (Continued)

between -0.00 and 0.01 vdc, within the 0.0 ± 0.3 vdc limits. The fire ullage ignition command was turned on, and it was verified that the ullage ignition pulse sensors were ON, while the ullage jettison pulse sensors remained OFF. The ignition firing unit indication voltages were then measured between 0.11 and 0.15 vdc, within the 0.0 ± 0.3 vdc limits.

The charge ullage jettison command was turned on, and it was verified that the six ullage ignition firing units remained uncharged, while the two jettison firing units properly charged. The ignition firing unit indication voltages were measured between 0.01 and 0.03 vdc, within the 0.0 ± 0.3 vdc limits, and the jettison firing unit indications were measured between 4.19 and 4.22 vdc, within the 4.2 ± 0.3 vdc limits. The fire ullage jettison command was turned on, and it was verified that the ullage ignition pulse sensors remained OFF, while the ullage jettison pulse sensors were ON. The ullage jettison firing unit indication voltages were then measured between 0.14 and 0.15 vdc, within the 0.0 ± 0.3 vdc limits.

The ullage rocket firing unit disable command was turned on, and the indication voltages of all ullage ignition and jettison firing units were measured between -0.00 and 0.04 vdc, within the 0.0 ± 0.3 vdc limits. The charge ullage ignition and charge ullage jettison commands were turned on, and the indication voltages of all ignition and jettison firing units were again measured between -0.00 and 0.02 vdc, within the 0.0 ± 0.3 vdc limits, indicating that the firing unit disable command properly prevented charging of the firing units. The firing unit disable command was turned off, and it was verified that all of the ullage ignition and jettison firing units

4.2.24 (Continued)

properly charged. The indication voltages of all firing units were measured between 4.19 and 4.29 vdc, within the 4.2 $\pm$ 0.3 vdc limits.

The ullage rocket firing unit disable command was turned back on, and the fire ullage ignition and fire ullage jettison commands were turned on. All of the ullage ignition and jettison pulse sensors were verified to be OFF, and the ignition and jettison firing unit voltage indications were measured between 0.01 and 0.03 vdc, within the 0.2 $\pm$ 0.3 vdc limits, verifying that the disable command would prevent firing of the firing units, and would safely discharge the charged firing units. The ullage rocket firing unit disable command was turned off, and the pulse sensor power was turned off.

A series of EBW pilot relay reset checks were then accomplished. It was verified that the charge command reset signal would properly reset the EBW pilot relays following the charge ullage ignition or charge ullage jettison commands, and that the fire command reset signal would properly reset the EBW pilot relays following the fire ullage ignition or fire ullage jettison commands. This completed the EBW test, and the stage power turnoff procedure was used to shut down the stage. The computer printout and typeout recorded that each of the EBW firing units was cycled three times, and the switch selector was used 71 times, during this performance of the test.

Engineering comments indicated that there were no parts shortages at the start of this test. No discrepancies or problems were encountered during the test, and no failure and rejection reports were written. Six revisions were made to the procedure for the following:

4.2.24 (Continued)

a. One revision added the Model DSV-4B-289 digital events recorder, P/N 1B39013-1, to the Mandatory End Items list, and deleted it from the Optional End Items list, to meet NASA requirements for the use of the unit.

b. One revision changed the Running Time/Cycle Record paragraph to include switch selector, P/N 50M67864-5, as a cycle significant item, and to require keeping time/cycle data on this item.

c. One revision changed a program "Go To" command, to ensure that the firing units were properly charged before the test routine was re-entered after a malfunction.

d. One revision deleted two print statements, and added "Do not intervene" commands to five other statements, to reduce the time between sending the firing unit disable command and the fire commands when verifying that the disable command prevented firing of the firing units. One other revision deleted the "Do not intervene" command for one of these statements, as the previous step could not be verified correctly within the 5 millisecond period between steps.

e. One revision reworded a preliminary setup paragraph to enable the use of the integrated test tape, as this tape was not called out on the release EO.

No modification or rework effort was anticipated that would invalidate this test, and the exploding bridgewire system was accepted for further use.

4.2.25 Pneumatic Control System Leak Check (1B59430 B)

This procedure detailed the manual steps required to check the components of the pneumatic control system for leakage in excess of design specifications. This system consisted of a helium sphere, a helium fill module, a pneumatic control module, a plenum chamber, six actuation control modules, the engine and LOX chilldown pump purge modules, and associated plumbing and circuitry. This system supplied the pneumatically operated valves and purge systems on the stage with GHe for valve operation and purging.

Testing began on 16 February 1967, and was terminated on 21 February 1967. Testing was active for portions of 4 days in this interval. The results of the test were accepted by Engineering on 9 March 1967. Directional Control Valve, P/N 1A49988-1, S/N 7, was installed as an interim use part for this test. Directional Control Valve, P/N 1A49988-501, was to be installed prior to static firing at STC.

System testing began by pressurizing the system to perform a leak check of the APS lines, followed in succession by leak checking the engine and LOX chilldown pump purge pressure switches, the lines to the pneumatic control module, the control helium supply line, the vent and relief valves, the directional control valve, the fill and drain valves, the prevalves, the shutoff valves, the LOX chilldown and engine pump purge control modules, and the start tank vent valve.

Upon completion of the leak checks, a pressure decay test was performed to ensure that all components were within the design leakage requirements. The pneumatic control sphere was pressurized to 700 ± 50 psia, after the system valves were set to specific positions, and allowed to stabilize for 30 minutes.

4.2.25 (Continued)

At the end of the stabilization period a pressure of 737 psig was recorded. After another 30 minutes a pressure of 733 psig was recorded.

At the conclusion of the third time period the valve positions were changed and the control sphere was again allowed to stabilize for 30 minutes. A pressure of 720 psig was recorded at the end of the 30 minute stabilization period. After another 30 minutes a pressure of 714 psig was recorded. This concluded the pressure decay test, which was acceptable to Engineering.

Fifteen leakage conditions were noted, as shown in Table 4.2.25.1. Five leakage conditions were resolved by retightening the connections to the torque value. Five leakage conditions were resolved by replacing seals. One leakage condition required the replacement of a fitting, MC160C4W. One leakage condition was amended by replacement of a union. One leakage condition was resolved by a realignment of the module concerned. One leakage condition was resolved by a revision deleting the requirement at that point, as an interim use part was installed and the leakage condition was not applicable. The method of correcting one condition of leakage was not noted.

One FARR, A196161, was written during the operation of this test procedure because the directional control valve, P/N 1A49988-1, S/N 7, had leakage of 630 scims at the end cap assembly on the actuator piston close C port. The high leakage at this point was acceptable for stage checkout purposes; however, the directional control valve was to be replaced prior to static firing at STC.

There were thirteen revisions written during the operation of this procedure. The revisions were:

a. One revision changed several procedural steps to include the use of checkout equipment to improve checkout accuracy and safety.

4.2.25 (Continued)

b. Two revisions changed several procedural steps to comply with TAN 11049 R1 dated 3 March 1967.

c. One revision corrected a typing error to correct a 1 scim to 10 scim maximum allowable leakage for the start tank vent solenoid valve seat, with the valve closed.

d. One revision changed the maximum allowable leakage for the start tank solenoid valve seat, with the valve open, to 30 scim to reflect the latest change in specification control drawing 1A58345 AE.

e. One revision changed the A659-1B50914-PTE-301-1-85 breakout board kit to the -87 kit, in revision 1 because the -85 kit was not available.

f. One revision added a step to close the checkout valves (two), P/N 1B53817-505, in the aft skirt and on the thrust structure, to correct a procedural omission.

g. One revision was written to delete two revisions that were erroneously written duplicating two revisions previously written. The duplication occurred because of an error in revision numbering.

h. One revision was written to: (1) Delete a revision erroneously deleting, in two steps, the requirement to record the leakage measured at specific locations; (2) Add to step 4.2.6.a.4 of the H&CO, "Maximum allowable 50 sccm. Actual _____." to specify allowable internal leakage of the directional control valve per Specification Control Drawing 1A49988; and (3) Delete the note following the above mentioned step.

i. One variation revision was written to delete step 4.2.6.a.4 of the H&CO because the valve installed (S/N 7) is an interim use part per SEO 1A49988-001.

There were no modifications or EO's pending that would void the results of this test. All problems were resolved in a satisfactory manner and the system was accepted for use.

4.2.25.1 Test Data Table, Pneumatic Control System Leak Check

Leakage:

| Part Number | Name/Location | Remedy |
|---|---|---|
| 1B52451 | Pipe Assembly - Aft Skirt, Umbilical Area. | Replaced MC160C4W fitting and retorqued B-nuts. |
| 1B67224-1 | Pipe Assembly - 403A73. | Replaced seal. |
| 1B64821-1 | Pipe Assembly - Aft Skirt at Chilldown Pump. | Retorqued B-nuts. |
| 1B52537-1 | Pipe Assembly - Forward Skirt at Feed Through. | Retorqued B-nuts. |
| 1B64159-1 | Pipe Assembly - Skirt below Vent Valve. | Retorqued B-nuts. |
| 1B67225-1 | Pipe Assembly - Forward End of Plenum Chamber. | Replaced seals. |
| 1A58347-507 | Purge Module - 403A73A2. | Replaced seals. |
| 1B52523-1 | Pipe Assembly - Aft Skirt above A4. | Replaced union. |
| 1B67233-1 | Flange - Thrust Structure A73 Panel. | —— |
| 1B66500-1 | Pipe Assembly - LOX Chilldown Pump. | Replaced seals. |
| 1B64153-1 | Pipe Assembly - Vent and Relief Valve. | Retorqued. |
| 1B64864-1 | Pipe Assembly - Vent and Relief Valve. | Retorqued. |
| 1B64864-1 | Pipe Assembly - Vent and Relief Valve. | Replaced seals. |
| 1B52446-1 | Module - A9 Panel. | Realigned and retorqued. |
| 1A49988-1 | Directional Control Valve - End Cap on Piston Assembly C Port. | None - IUM. |

4.2.25.1 (Continued)

Pressure Switch Check:

| Name | Pressure | | |
|---|---|---|---|
| | Pickup - Continuity | Dropout - No Continuity | Minimum Deadband (Differential) |
| Engine Pump Purge Pressure Switch | 109.5 psig Initial<br>109.0 psig 1 cycle<br>109.0 psig 2 cycle | 95.0 psig Initial<br>95.0 psig 1 cycle<br>95.0 psig 2 cycle | 14.0 psig |
| LOX Chilldown Pump Pressure Switch | 37.8 psig Initial<br>37.75 psig 1 cycle<br>37.7 psig 2 cycle | 35.5 psig Initial<br>35.5 psig 1 cycle<br>35.5 psig 2 cycle | 2.2 psig |

Module Check:

| Name | Leakage Measurement |
|---|---|
| Ambient He Fill Module Dump Valve | 0 scim |
| $LH_2$ Vent & Relief Valve Control Module | 0 scim |
| $LH_2$ Directional Vent Valve Control Module | 0 scim |
| LOX Fill & Drain Valve Control Module | 0 scim |
| $LH_2$ Fill & Drain Valve Control Module | 0 scim |
| LOX Vent & Relief Valve Control Module | 0 scim |
| Prevalve & Chilldown Valve Control Module | 0 scim |

Valve Check:

| Name | Leakage Measurement | |
|---|---|---|
| | Open Side | Closed Side |
| $LH_2$ Vent & Relief Valve | Vent Port 1 sccm<br>Opening Piston<br>Vent 0 scim | Vent Port 1 sccm |

4.2.25.1 (Continued)

| Name | Leakage Measurement | |
|---|---|---|
| | Open Side | Closed Side |
| $LH_2$ Fill & Drain Valve | Vent Port 0 sccm<br>Max. 20 sccm | Vent Port 0 sccm<br>Max. 20 sccm<br><br>Position Switch Housing 36 sccm<br>Max. 300 sccm |
| LOX Vent & Relief Valve | Opening Piston Vent Port 0 sccm<br>Max. 150 sccm<br><br>Vent Port 0 sccm<br>Max. 20 sccm | Vent Port 0 sccm<br>Max. 20 sccm |
| LOX Fill & Drain Valve | Vent Port 0 sccm<br>Max. 20 sccm | Vent Port 0 sccm<br>Max. 20 sccm<br><br>Position Switch Housing 0 sccm<br>Max. 300 sccm |
| | Flight Side | Ground Side |
| Directional Control Valve | Vent Port 1.7 sccm<br>Max. 20 sccm<br><br>Control Piston Seal 0 sccm<br>Max. 50 sccm<br><br>Unlocking Piston Seal 0 sccm | Vent Port 9.9 sccm<br>Max. 20 sccm<br><br>Control Piston Seal 0 sccm<br>Max. 50 sccm<br><br>Unlocking Piston Seal |
| | Leakage Measurement | |
| LOX Prevalve | Inlet Port 5 sccm<br>Max. 20 sccm<br><br>Piston Vent Port 0 sccm<br>Max. 300 scim | |
| $LH_2$ Prevalve | Inlet Port 0 sccm<br>Max. 20 sccm | |

4.2.25.1 (Continued)

| Name | Leakage Measurement | |
|---|---|---|
| LOX & $LH_2$ Prevalve Control Module | Vent Port<br>Max. 20 sccm | 9 sccm |
| LOX Chilldown Pump | Seal-Drain Overboard Vent<br>Max. 8 scim | 3.9 scim |
| LOX Chilldown Pump | Internal Leakage<br>Max. 16 scim | 0 scim |
| Pump Purge Dump Valve | Internal Leakage<br>Max. 25 sccm | 0 sccm |
| Start Tank Vent Valve | Seat Leakage<br>Valve Closed<br>Valve Open<br>Max. 1 scim | <br>0 scim<br>0 scim |
| Pneumatic Control Valve | Seat Leakage<br>Max. 10 scim | 2.35 scim |

4.2.26 Forward Skirt Thermoconditioning System Securing (1B62965 A)

A first issue release of this procedure was used to temporarily shutdown the stage for removal from the VCL tower to perform rework on the helium bottles. Only those portions of the procedure necessary to remove the stage from the tower were performed. This partial use first issue was completed on 21 February 1967. The following discussion is about the second issue procedure, except as noted in the discussion.

The second issue procedure was used to secure the forward skirt thermoconditioning system, subsequent to VCL automatic checkout activities, and consisted of a system cleanliness check, a drain and dry procedure, a dry leak check, and preparations for stage shipment to STC. All of these activities were accomplished by the second issue release on 22 March 1967, with Engineering review and acceptance occurring on the same day.

The Model DSV-4B-359 thermoconditioning servicer, P/N 1A78829-1, was verified to be properly set up and connected to the stage thermoconditioning system. A visual inspection verified that there was no leakage within the servicer, at the coolant supply and return hose assemblies, P/N's 1B37641-1 and -501, leading to the stage, or within the stage thermoconditioning system.

The system cleanliness check began with an inspection of the cold plates for open mounting holes and improperly torqued bolts. Coolant was circulated through the system, and 1000 milliliter samples of the water/methanol coolant solution were drawn from the fluid sample pressure valve and the fluid sample return, after one pint of fluid had been drawn from each valve to purge the valves of possible impurities. The samples were then analyzed for cleanliness per 1P00093, and were found to be acceptable.

4.2.26 (Continued)

The drain and dry procedure was begun by purging the stage thermoconditioning system with $GN_2$ for 35 minutes. The remaining coolant fluid was drained from fluid sample pressure and return valves and the air test valve, then $GN_2$ was flowed through the system for 2 1/2 hours. It was then verified that the system's moisture content was less than 4430 parts per million of water/methanol vapor, equivalent to a $25^{\circ}F$ dewpoint.

The stage thermoconditioning system was purged with freon gas, then the system was pressurized to $32 \pm 1$ psig for a leak check. All system B-nuts and fittings, manifold weld areas, panel inlet and outlet boss welds, and manifold flexible bellows were leak checked using a gaseous leak detector, P/N 1B37134-1, with the sensitivity switch set to 1 on the R12-OZ/YR scale. No leaks were found in any of these areas.

At the conclusion of the test, the system dewpoint was again checked, and found to be acceptable. The thermoconditioning system was active for a total of 2 hours 12 minutes.

There were no revisions written against the second issue; however, a variation serial engineering order (SEO) was written to prevent possible overpressurization of the freon bottle in the Model DSV-4B-359 servicer. Possible overpressurization could be caused by a combination of an open check valve and a shutoff valve left in the open position.

The first issue procedure, of necessity, had two revisions, which were:

a. One variation revision deleted all paragraphs in their entirety, except for portions of paragraphs 4.2.2, the drain and dry procedure, and 4.2.4, the preparation of thermoconditioning system for stage shipment. Only these portions of the paragraphs necessary to temporarily remove the stage from the tower for rework of the helium bottle spheres were used.

4.2.26 (Continued)

b. One variation revision changed the length of time for the $GN_2$ to flow through the servicer from 2 hours to 30 minutes during the drain and dry procedure.

No parts were short which affected this test, and no functional failures were reported on FARR's. The system was accepted as secured for shipment.

4.2.27 Cold Helium System Leak Check (1B59431 B)

The purpose of the cold helium system leak check test was to verify the integrity of the Saturn S-IVB cold helium system. This test procedure performed a manual leak check and a functional check of the cold helium system. The functional check of the cold helium system verified its capability to supply and regulate helium for the pressurization of the LOX tank.

Cold helium spheres, P/N 1A48858-1, S/N's 1024, 1134, 1143, 1148, 1154, and 1156; and plenum sphere, P/N 1A49991-1, S/N 35, and the associated tubing were checked functionally and for leakage, beginning on 24 February 1967, and concluded on 27 February 1967. The test was active for 3 days.

The test was initiated by setting up the GSE and providing access to the cold helium system components. All necessary access plates were removed and the LOX tank was isolated from the cold helium system by capping the pipe assemblies into the tank. The LOX tank pressure switches were pressurized, checked, and then vented. The cold helium spheres were pressurized to 50 psig, then the system was checked for major leaks upstream and downstream of the control module by listening for escaping gas. The cold helium dump valve was checked for proper operation by listening for escaping gas, when it was opened, and the cessation of escaping gas, when it was closed. The cold helium spheres were then pressurized to 500 psia and the cold helium discharge regulator was checked to ensure that pressure did not increase. The pressure in the spheres was increased to 750 psig and held for 3 minutes for the sphere integrity test.

4.2.27 (Continued)

After the spheres integrity test, the spheres were vented to 700 psig, through the cold helium dump valve. The pressurization supply line was next checked for leakage up to the fill module. The spheres manifold system was checked for leakage next. The cold helium dump valve vent system was checked for leakage as the spheres were vented to 500 psia. The cold helium fill module dump and relief valve, and the control module shutoff valves were checked for seat leakage.

The downstream portion of the cold helium system was the last part of the system checked. The cold helium system checked out all right after correcting minor leakage problems (see Test Data Table 4.2.27.1).

One FARR, A196162, was written during the operation of this test procedure to replace the Voi-Shan crush washer, P/N VSF 1015C4, at the connection of cap assembly, P/N MC177C4W, to pipe assembly, P/N 1B58807-1, as the leakage could not be stopped by retorquing.

No revisions were written against this procedure.

No modifications or E.O.'s were to be accomplished after completion of this test that would require retesting of this system. This test was acceptable to Engineering for use and was signed off on the Engineering Acceptance sheet on 22 March 1967.

4.2.27.1 <u>Test Data Table, Cold Helium System Leak Check</u>

| Part Number | Name/Location | Remedy |
|---|---|---|
| 1B64132-1 | Pipe assembly seal - engine interface. | Installed new seal. |
| 1B52399-1 | Pipe assembly "B" nut - aft umbilical disconnect. | Retorqued. |
| 1B52439-1 | Pipe assembly "B" nut - junction pipe 1B52413. | Retorqued. |
| 1B52439-1 | Pipe assembly "B" nut - main tunnel. | Retorqued. |
| 1B52415-1 | Pipe assembly "B" nut - main tunnel. | Retorqued. |
| 1A48858-1 | Manifold "B" nut - main tunnel. | Retorqued. |
| 1B52411-1 | Pipe assembly "B" nut - main tunnel at crossing. | Retorqued. |
| 1B52441-1 | Pipe assembly "B" nut - auxiliary tunnel. | Retorqued. |
| 1A48858-1 | Manifold "B" nut - auxiliary tunnel. | Retorqued. |
| M6177C4W | Cap "B" nut - pipe assembly 1B58807-1. | Retorqued. |
| 1B64132-1 | Pipe assembly "B" nut - at adapter 1B52432-501 to plenum sphere. | Retorqued. |
| 1B59284-1 | Pipe assembly "B" nut - at adapter 1B52432-501 to plenum sphere. | Retorqued. |
| 1A48858-1 | Manifold "B" nut - auxiliary tunnel. | Installed new union. |
| 1B52439-1 | Pipe assembly "B" nut - main tunnel. | Installed new union. |
| 1B52439-1 | Pipe assembly "B" nut - junction of pipe 1B52413-1. | Installed new union. |
| 1B64132-1 | Pipe assembly "B" nut - at adapter 1B52432-501. | Retorqued. |

4.2.27.1 (Continued)

| Part Number | Name/Location | Remedy |
|---|---|---|
| MC177C4W | Cap "B" nut - on pipe 1B58807-1. | Replaced cap. |
| MC177C4W | Cap "B" nut - on pipe 1B58807-1. | Installed Voi-Shan seal. |
| 1A68668-511 | Manifold "B" nut - auxiliary tunnel at union to pipe 1B52409-1, 1A48858-1 No. 5. | Retorqued. |

4.2.28 Range Safety Receiver Manual Operations (1B59829 D)

The range safety receiver manual operations procedure was used in conjunction with the automatic range safety receiver procedure, H&CO 1B59596, to verify that the range safety receivers were capable of properly receiving the modulated 450 MHz carrier used to control the engine cutoff, propellant dispersion, and system off functions within the stage. The particular items involved in this test were the range safety receivers, P/N 50M10697, S/N's 20 and 124, and the range safety control decoders, P/N 50M10698, S/N's 127 and 138.

This test procedure was conducted on 25 February 1967, and was accepted on 27 February 1967. The first step of the manual operations procedure was to determine the attenuation of the GSE test cables used with each range safety system. At the operating frequency of 450 MHz, the test cable for range safety system 1 had an attenuation of 29.7 db (A1), and the test cable for system 2 had an attenuation of 29.8 db (B1). The setup was then made for the deviation threshold and RF bandwidth checks. The GSE destruct system test set was adjusted for closed loop testing, with an output of -17 dbm at 450 MHz. On the stage, the range safety antennas were disconnected from directional power divider 411A97A56, and 50 ohm loads were connected to receptacles J2 and J6 of the power divider. For a -3 db RF bandwidth check, the output of the GSE test set was increased until the receiver 1 low level signal strength indication was 2.0 $\pm$ 0.1 vdc. This signal strength indication was recorded as the AGC reference voltage. The RF output power level indication was also measured, a factor of + 20 dbm was added, and the resulting value was recorded as the reference RF power level. The GSE test set output level was then increased by 3 dbm, and the output frequency

4.2.28 (Continued)

increased from 450 MHz until the receiver low level signal strength dropped to the AGC reference voltage level. The frequency at which this happened was recorded as the upper bandedge frequency. The GSE test set output frequency was then decreased below 450 MHz until the low level signal again dropped to the AGC reference voltage level, and the lower bandedge frequency was recorded. The difference between the upper and lower bandedge frequencies was determined and recorded as the -3 db bandwidth. The bandwidth midpoint frequency was determined and compared to 450 MHz, with the difference recorded as the bandwidth centering. All values recorded during the test are shown in Test Data Table 4.2.28.1.

A -60 db RF bandwidth check was conducted on receiver 1 in the same way, except that after initially adjusting the GSE test set output level to obtain the AGC reference voltage, the output level was increased by 60 dbm rather than 3 dbm. Bandwidth centering was not determined in this check. After the bandwidth checks of receiver 1 were completed, the same checks were made on range safety receiver 2.

After the RF bandwidth checks were completed, the GSE test set was readjusted for an output frequency of 450 $\pm$ 0.045 MHz, a deviation frequency of 5 $\pm$ 0.25 kHz, and an output level sufficient to give a -63 dbm input to receiver 1. Verification was made that no commands or tones were being sent to the receivers, and the automatic deviation threshold checks were conducted as specified in the automatic procedure, H&CO 1B59596. During these checks, the deviation was increased from 5 kHz as required by the computer typeout commands. The results of these checks are covered by the automatic procedure narration in paragraph 4.2.29.

4.2.28 (Continued)

Following the deviation threshold checks, the GSE test set output frequency was verified to be 450 MHz, and the output deviation frequency was adjusted to 60 ± 0.5 kHz. Verification was made that no commands were being sent to the receivers, and the automatic radio frequency sensitivity checks were conducted as specified by the automatic procedure. These checks are also covered in paragraph 4.2.29.

After the radio frequency sensitivity checks were completed, the 50 ohm loads were removed from receptacles J2 and J6 of power divider 411A97A56, and the stage range safety antennas were reconnected to the power divider. The output frequency of the GSE test set was verified to be 450 MHz, and the test set was adjusted for open loop operation. Verification was made that no commands or tones were being sent to the receivers, and the test set antenna coaxial switch was set to the specified first position. The test set output level was adjusted to -100 dbm, and then increased in 1 db increments until there was no further increase in the low level signal strength of the least sensitive receiver. It was verified that the signal strength of the more sensitive receiver was over 3 vdc at this point, and the output level was recorded as -92 dbm. With the test set antenna coaxial switch in the second position, the above check was repeated with the output level recorded as -93 dbm. The test set antenna coaxial switch was returned to the first position, and the output level was adjusted until the least sensitive receiver had a low level signal strength corresponding to an input between -93 and -87 dbm. The test set output level at this point was to be recorded, but the receiver low level signal strength of 3.6 vdc was recorded instead. The open loop RF checks specified in the

4.2.28 (Continued)

automatic procedure were then performed. These checks are covered in paragraph 4.2.29. This completed the range safety receiver manual operations.

Engineering comments indicated that all parts were installed at the start of this test. No discrepancies were noted during the test, and no failure and rejection reports or revisions were written. No modification or rework effort was anticipated that would invalidate this test, and the range safety receivers were accepted for use.

4.2.28.1 Test Data Table, Range Safety Receiver Manual Operations

-3 db RF Bandwidth Check

| Function | Receiver 1 | Receiver 2 | Limits |
|---|---|---|---|
| AGC Reference Voltage (vdc) | 2.0 | 2.0 | 2.0 ± 0.1 |
| Reference RF Power Level (dbm) | -70. | -73. | - |
| Upper Bandedge Frequency (MHz) | 450.146 | 450.154 | - |
| Lower Bandedge Frequency (MHz) | 499.816 | 449.803 | - |
| -3 db Bandwidth (kHz) | 330. | 351. | 340 ± 30 |
| Bandwidth Centering (kHz) | 19. | 22. | 33.8 max. |

-60 db RF Bandwidth Check

| Function | Receiver 1 | Receiver 2 | Limits |
|---|---|---|---|
| AGC Reference Voltage (vdc) | 2.0 | 2.0 | 2.0 ± 0.1 |
| Reference RF Power Level (dbm) | -70. | -70. | - |
| Upper Bandedge Frequency (MHz) | 450.460 | 450.532 | - |
| Lower Bandedge Frequency (MHz) | 449.489 | 449.460 | - |
| -60 db Bandwidth (MHz) | 0.971 | 1.072 | 1.2 max. |

4.2.29 Range Safety Receiver Checks (1B59596 D)

This automatic procedure verified the functional capabilities of the range safety receivers prior to their use in the range safety system checkout. The receivers were checked for automatic gain control (AGC) calibration and drift, minimum acceptable deviation sensitivity, minimum acceptable RF sensitivity, and open-loop operation. The Range Safety Receiver Manual Operations, H&CO 1B59829, covered in paragraph 4.2.28, was used as required in conjunction with this automatic procedure. The items involved in this test were the range safety receivers 411A97A14, P/N 50M10697, S/N 124 (receiver 1) and 411A97A18, S/N 20 (receiver 2), and the range safety decoders 411A99A1, P/N 50M10698, S/N 138 (decoder 1) and 411A99A2, S/N 0127 (decoder 2).

Initiated on 25 February 1967, this procedure was completed and accepted on 27 February 1967, after 2 days of activity One test run was conducted during this period. The test run was successfully completed on 27 February with no malfunctions. The results reported in this paragraph and in Test Data Table 4.2.29.1 are from this test run.

Initial test conditions were established, and the range safety receivers were turned on. The test cable insertion loss values A1 and B1 were obtained from the manual operations procedure and loaded into the computer for use in this program.

The manual operations procedure was used to prepare the GSE destruct system test set, and the stage antennas, for the AGC calibration check. For each input signal level used in the calibration check, the computer determined the GSE test set output level required to compensate for the test

4.2.29 (Continued)

cable insertion loss, and, when requested by the computer typeout, the GSE test set was manually adjusted to these output levels. The computer then determined the input signal levels and measured the low-level signal strength (AGC telemetry voltage) of each receiver. These AGC measurements, in the 0 to 5 vdc range, were multiplied by a conversion factor of 20 and presented as a per cent of full-scale values. The AGC calibration check was conducted twice, and the difference in AGC values at each step was determined for the AGC drift check. The AGC values were all acceptable, and the drift deviations were well below the 3 per cent full-scale maximum limit.

The manual operations procedure was used to prepare for the deviation threshold check. During this check, the receiver input levels were fixed at -63 dbm for receiver 1, and -63.1 dbm for receiver 2. A series of checks determined the minimum input deviation frequency at which each receiver would respond to the range safety commands. For each command, the GSE test set was manually adjusted to a sequence of deviation frequencies increasing from 5 kHz as requested by the computer typeout. At each deviation frequency, the range safety control decoders were checked for the presence of the command signal from the appropriate receiver. Both receivers responded to all commands at minimum deviation frequencies well below the 50 kHz maximum limit.

The manual operations procedure was used to prepare for the RF sensitivity checks, which were conducted with the GSE test set deviation frequency fixed at 60 kHz. A series of checks determined the minimum input signal level at which each of the receivers would respond to the range safety commands. For each command, the GSE test set output was manually adjusted to a sequence of

4.2.29 (Continued)

levels increasing from -85.3 dbm, as requested by the computer typeout. This gave input levels increasing from -115.0 dbm for receiver 1, and increasing from -115.1 dbm for receiver 2. At each input level, the range safety control decoders were checked for the presence of the command signal from the appropriate receiver. Both receivers responded to minimum input levels below the -93 dbm maximum limit.

The manual operations procedure was used to prepare for the open-loop RF checks. Under open-loop conditions, the low-level signal strength (AGC telemetry voltage) of receiver 1 was 3.835 vdc, while that of receiver 2 was 3.646 vdc. The range safety commands were transmitted from the GSE test set, and checks of the decoder signals showed that both receivers responded properly to the open-loop transmission. The PCM RF assembly power was turned on, and the range safety commands were again transmitted. Checks of the decoder signals showed that both receivers responded properly and were not adversely affected by the PCM RF transmission. The PCM RF assembly power and the range safety receiver power were turned off, completing the range safety receiver checks. The computer printout indicated that the switch selector had been used 52 times during this test run.

Engineering comments noted that all parts were installed at the start of this test. Four revisions were written to this procedure. The four revisions were:

a. One revision changed the heading of the H&CO paragraph 3.1 to read Mandatory End Item Equipment, to clarify the requirements.

b. One revision added the Digital Events Recorder, P/N 1B39013-1, Model DSV-4B-289 to the Mandatory End Item Equipment list and deleted it from the Optional End Items list.

4.2.29 (Continued)

c. One revision to comply with test requirements, deleted two statements from the procedure.

d. One revision changed a statement to ensure that the range safety receiver 2 propellant dispersion cutoff command inhibit signal was reset.

No failures occurred during this test. No modification or rework effort was anticipated that would invalidate the results of this test, and the range safety receivers were accepted for further use.

## 4.2.29.1 Test Data Table, Range Safety Receiver Checks

### AGC Calibration and Drift Checks

(% = Per Cent of Full-Scale)

| TEST SET OUTPUT (dbm) | RECEIVER 1 INPUT (dbm) | AGC 1 (%) RUN 1 | AGC 1 (%) RUN 2 | AGC 1 DRIFT (%) | RECEIVER 2 INPUT (dbm) | AGC 2 (%) RUN 1 | AGC 2 (%) RUN 2 | AGC 2 DRIFT (%) |
|---|---|---|---|---|---|---|---|---|
| -97.3 | -127.0 | 13.020 | 13.320 | 0.29 | -127.1 | 27.500 | 27.500 | 0.00 |
| -90.3 | -120.0 | 13.540 | 13.440 | 0.10 | -120.1 | 27.720 | 28.040 | 0.31 |
| -85.3 | -115.0 | 14.160 | 14.060 | 0.10 | -115.1 | 28.340 | 27.920 | 0.41 |
| -80.3 | -110.0 | 16.680 | 16.160 | 0.51 | -110.1 | 30.240 | 30.560 | 0.31 |
| -75.3 | -105.0 | 22.360 | 22.460 | 0.10 | -105.1 | 37.160 | 36.740 | 0.41 |
| -70.3 | -100.0 | 36.640 | 37.900 | 1.23 | -100.1 | 51.560 | 51.660 | 0.10 |
| -65.3 | - 95.0 | 61.220 | 61.220 | 0.00 | - 95.1 | 68.780 | 68.980 | 0.20 |
| -60.3 | - 90.0 | 75.720 | 75.820 | 0.10 | - 90.1 | 74.560 | 74.460 | 0.10 |
| -55.3 | - 85.0 | 78.340 | 78.240 | 0.10 | - 85.1 | 74.980 | 74.980 | 0.00 |
| -50.3 | - 80.0 | 79.080 | 78.960 | 0.12 | - 80.1 | 75.180 | 75.180 | 0.00 |
| -45.3 | - 75.0 | 79.700 | 79.600 | 0.10 | - 75.1 | 75.400 | 75.180 | 0.21 |
| -40.3 | - 70.0 | 79.600 | 79.600 | 0.00 | - 70.1 | 75.500 | 75.300 | 0.20 |

### RF Sensitivity Checks

| | MINIMUM DEVIATION (kHz) RECEIVER 1 | MINIMUM DEVIATION (kHz) RECEIVER 2 | MINIMUM INPUT (dbm) RECEIVER 1 | MINIMUM INPUT (dbm) RECEIVER 2 |
|---|---|---|---|---|
| Arm and Engine Cutoff Command | 15.0 | 15.0 | -105.0 | -105.1 |
| Propellant Dispersion Command | 15.0 | 15.0 | -105.0 | -105.1 |
| Range Safety System Off Command | 15.0 | 15.0 | -105.0 | -105.1 |

4.2.30 Range Safety System (1B59482 D)

The automatic checkout of the range safety system verified the system external/internal power transfer capability; and the capability of the system to respond to the propellant dispersion inhibit and trigger commands, the engine cutoff command, and the system off command. The particular items involved in this test included the following:

| PART NAME | REFERENCE LOCATION | P/N | S/N |
|---|---|---|---|
| Range Safety Receiver 1 | 411A97A14 | 50M10697 | 124 |
| Range Safety Receiver 2 | 411A97A18 | 50M10697 | 20 |
| Secure Command Decoder 1 | 411A99A1 | 50M10698 | 0138 |
| Secure Command Decoder 2 | 411A99A2 | 50M10698 | 0127 |
| Secure Command Controller 1 | 411A97A13 | 1B33084-503 | 04 |
| Secure Command Controller 2 | 411A97A19 | 1B33084-503 | 06 |
| RS System 1 EBW Firing Unit | 411A99A12 | 40M39515-119 | 448 |
| RS System 2 EBW Firing Unit | 411A99A20 | 40M39515-119 | 431 |
| RS System 1 EBW Pulse Sensor | 411A99A31 | 40M02852 | * |
| RS System 2 EBW Pulse Sensor | 411A99A32 | 40M02852 | * |
| Safe and Arm Device | 411A99A22 | 1A02446-503 | * |
| Directional Power Divider | 411A97A56 | 1B38999-1 | 00019 |
| Hybrid Power Divider | 411A97A34 | 1A74778-501 | 045 |
| * Installed in Pulse Sensor Assembly | - | 1B29054-501 | 00003 |

This procedure was satisfactorily conducted on 25 February 1967, and was accepted on 27 February 1967. Values measured during the test are shown in Test Data Table 4.2.30.1.

Initial conditions were established for the test, and the GSE destruct system test set, Model DSV-4B-136, P/N 1A59952-1, was set up with a -50 dbm output level. The forward bus 1 and 2 battery simulators were turned on, the receivers for range safety systems 1 and 2 were verified OFF, and the forward bus voltages were measured.

The external/internal power transfer test was then entered into by verifying that the EBW firing units were off, then external power to the receivers and

4.2.30 (Continued)

firing units of both systems was turned on. Measurements were then made of the cutoff destruct indications, the firing unit charging voltage indications, and the firing unit indications for both range safety systems.

The cutoff command inhibit to the receivers was turned on, then the firing units were transferred to internal power and the external power for the units was turned off. It was verified that the units remained on and the charging voltages were correct. The firing units were transferred back to external power and verified to be off, and the firing unit charging voltages were again measured for the correct indications.

External power for the receivers was turned off and the receivers were transferred to internal power, and verified to be on. The receivers were then transferred to external power and verified to be off, then transferred to internal power and again verified to be on.

The EBW firing unit arm and engine cutoff test was conducted next. The engine control bus power was turned on and measured, then the low level signal strength for both receivers was measured. Each range safety system was then individually tested as stated below. System 1 was tested first. The EBW firing unit arm and engine cutoff command was turned on and verified as received by the system under test. The appropriate firing unit charging voltage indication was measured. Verification was made that the engine cutoff indication was OFF at the umbilical and through the AO and BO telemetry multiplexers; that the non-programmed engine cutoff indication was OFF; and that the instrument unit arm and engine cutoff indication for the receiver under test was OFF. For the system under test, the receiver cutoff command inhibit

4.2.30 (Continued)

was then turned off, and it was verified that the instrument unit arm and engine cutoff indication for the receiver not under test was OFF.

Verification was made that the engine control bus power was off, that the engine cutoff indication was OFF at the umbilical and through the AO and BO multiplexers; that the non-programmed engine cutoff indication was OFF; and that the instrument unit arm and engine cutoff indication for the receiver under test was ON. The receiver cutoff command inhibit was again turned on, and the EBW firing unit arm and engine cutoff command was turned off. The latter command was turned back on, the cutoff destruct indication was measured for the system under test, and the command was again turned off.

Following the test of system 1, and prior to the test of system 2, both firing units were transferred to external power and verified to be OFF, and the charging voltage indications were measured. The switch selector engine ready bypass command was turned on, and the engine cutoff indication at the umbilical was verified as being OFF. The above steps were then repeated to test system 2. Following the system 2 test, the EBW pulse sensor power was turned on and both pulse sensor indications were verified as being OFF.

Again, each range safety system was individually tested by the following steps, starting with system 1. The propellant dispersion command was turned on and verified as being received by the receiver under test. The appropriate firing unit charging voltage indication was measured, and the appropriate pulse sensor indication was verified as being OFF. The propellant dispersion command was turned off, the cutoff command inhibit for the receiver under test was turned off, and the propellant dispersion command was turned back on and

4.2.30 (Continued)

verified as being received by the receiver under test. For the system under test, the firing unit charging voltage was measured, and the pulse sensor indication was verified as being ON. The cutoff command inhibit was turned back on, and the propellant dispersion command was turned off. The latter command was turned back on, the cutoff destruct indication was measured, and the command was again turned off. The above steps were then repeated to test system 2. After the test of system 2, the cutoff command inhibit was turned off for both receivers.

The range safety system off test was started next. The range safety system off command was turned on, and power for receiver 1 and the system 1 EBW firing unit was verified as being OFF. The range safety system off command was turned off, receiver 2 was transferred to internal power, the range safety system off command was turned back on, and the power for receiver 2 and the system 2 EBW firing unit was verified as being OFF. The range safety system off command was turned back off, and the cutoff destruct indications were measured for both systems.

The safe and arm device was tested next. The safe-arm safe command was turned on, the safe indication was verified as being ON, and the arm indication was verified as being OFF. The safe-arm arm command was turned on, the safe indication was verified as being OFF, and the arm indication was verified as being ON. The safe-arm safe command was turned back on, and again the safe indication was verified as being ON, and the arm indication was verified as being OFF. This completed the range safety system tests.

4.2.30 (Continued)

Engineering comments indicated that all parts were installed at the start of this procedure. One minor problem was encountered during this procedure due to improperly connected EBW pulse sensors. Testing was interrupted to correct this problem. No failure and rejection reports were written against the procedure. A total of seven revisions were made to the procedure as follows:

a. One revision changed the status of the Model DSV-4B-289 Digital Events Recorder to a Mandatory End Item from an Optional End Item per request of NASA.

b. One revision deleted a procedural step to turn on the engine control bus power, because the control bus power was inhibited.

c. One revision changed a procedural step to read "If engine control power is ON", because the bus power should be off.

d. One revision changed a procedural step to read "Engine control bus power is OFF", because the bus power will be off.

e. One revision deleted a procedural step to "Wait until engine control bus voltage is 28 vdc", because the engine control bus power should be off.

f. One revision deleted four procedural steps to turn on the engine switch selector ready bypass, because the engine control power is off, and the engine ready bypass will not function.

g. One revision deleted a procedural step to read time into time cell 37, in order to preserve an accurate running time of range safety receiver operation.

No modification or rework effort was anticipated that would invalidate results of this test, and the range safety system was accepted for use.

4 2.30 1 Test Data Table, Range Safety System

| FUNCTION | MEASURED VALUE | LIMITS |
| --- | --- | --- |
| Forward Bus 1 Battery Simulator | 28.158 vdc | 28 ± 2 vdc |
| Forward Bus 2 Battery Simulator | 28.079 vdc | 28 ± 2 vdc |

4.2.30.1 (Continued)

External/Internal Power Transfer Test

| External Power On | MEASURED VALUE | LIMITS |
|---|---|---|
| System 1 Cutoff Destruct Indication | 1.215 vdc | 1.28 ± 0.3 vdc |
| System 1 Charging Voltage Indication | 4.215 vdc | 4.2 ± 0.3 vdc |
| System 1 Firing Unit Indication | 4.220 vdc | 4.2 ± 0.3 vdc |
| System 2 Cutoff Destruct Indication | 1.220 vdc | 1.28 ± 0.3 vdc |
| System 2 Charging Voltage Indication | 4.234 vdc | 4.2 ± 0.3 vdc |
| System 2 Firing Unit Indication | 4.240 vdc | 4.2 ± 0.3 vdc |
| Internal Power | | |
| System 1 Charging Voltage Indication | 4.194 vdc | 4.2 ± 0.3 vdc |
| System 2 Charging Voltage Indication | 4.260 vdc | 4.2 ± 0.3 vdc |
| External Power Off | | |
| System 1 Charging Voltage Indication | 0.024 vdc | 0.3 vdc max. |
| System 2 Charging Voltage Indication | 0.079 vdc | 0.3 vdc max. |

Firing Unit Arm and Engine Cutoff Test

| | | |
|---|---|---|
| Engine Control Bus Power | 27.691 vdc | 28 ± 2 vdc |
| Receiver 1 Signal Strength Indication | 3.85 vdc | 3.75 ± 1.25 vdc |
| Receiver 2 Signal Strength Indication | 3.66 vdc | 3.75 ± 1.25 vdc |
| System 1 Arm and Engine Cutoff Test | | |
| Firing Unit Charging Voltage Indication | 4.249 vdc | 4.2 ± 0.3 vdc |
| Cutoff Destruct Indication | 2.29 vdc | 2.43 ± 0.3 vdc |
| External Power Off | | |
| Engine Control Bus Power | 27.722 vdc | 28 ± 2 vdc |
| System 1 Charging Voltage Indication | 0.079 vdc | 0.3 vdc max. |
| System 2 Charging Voltage Indication | 0.045 vdc | 0.3 vdc max. |

4.2.30.1 (Continued)

| FUNCTION | MEASURED VALUE | LIMITS |
|---|---|---|
| System 2 Arm and Engine Cutoff Test | | |
| Firing Unit Charging Voltage Indication | 4.234 vdc | 4.2 ± 0.3 vdc |
| Cutoff Destruct Indication | 2.28 vdc | 2.43 ± 0.3 vdc |
| System 1 Propellant Dispersion Test | | |
| Charging Voltage Indication (Pulse Sensor OFF) | 4.225 vdc | 4.2 ± 0.3 vdc |
| Charging Voltage Indication (Pulse Sensor ON) | 1.564 vdc | 3.0 vdc max. |
| Cutoff Destruct Indication | 2.99 vdc | 3.16 ± 0.3 vdc |
| System 2 Propellant Dispersion Test | | |
| Charging Voltage Indication (Pulse Sensor OFF) | 4.234 vdc | 4.2 ± 0.3 vdc |
| Charging Voltage Indication (Pulse Sensor ON) | 1.529 vdc | 3.0 vdc max. |
| Cutoff Destruct Indication | 2.97 vdc | 3.16 ± 0.3 vdc |
| Range Safety System Off Test | | |
| System 1 Cutoff Destruct Voltage | 0.087 vdc | 0 ± 0.3 vdc |
| System 2 Cutoff Destruct Voltage | 0.092 vdc | 0 ± 0.3 vdc |

4 2 31 J-2 Engine System Leak Check (1B59433 B)

The manual leak check of the J-2 engine system was subdivided into two separate procedures. The J-2 engine leak check, initiated on 25 February 1967, and completed on 4 March 1967, began with the pressurization, leak check, and depressurization of the start sphere. This was followed by pressurization and leak check of the control sphere. Subsequently, the pneumatic lines were leak checked by energizing the helium control, ignition phase control, start tank discharge control, and mainstage control solenoids. The thrust chamber leak check involved pressurization of the chamber, and leak checks of the system, under pressure, downstream of the main fuel and oxidizer valves, and the engine portion of the $LH_2$ tank pressurization system.

The J-2 engine testing began with the start tank integrity check, which included pressurizing the tank to 100 psia. The proper operation and integrity of the start tank vent and supply valves were checked. The tank was then pressurized to $650 \pm 25$ psia and checked for leaks. Finally, the fill line was leak checked. The control bottle integrity and leak check consisted of first verifying the integrity and operation of the vent and supply valves, and then pressurizing the bottle to $1750 \pm 50$ psia and checking for leaks. Subsequently, all associated pneumatic lines and solenoid valves were leak checked satisfactorily after correcting two leaks discussed below.

The thrust chamber leak check included examination for leakage at: the fuel tank pressurization control module to engine injector connection; the thrust chamber purge and chilldown line from the aft umbilical disconnect to the thrust chamber; the augmented spark igniter (ASI) oxidizer to ASI chamber connection; the connections on the ASI fuel supply line; the main oxidizer

4.2.31 (Continued)

valve and injector connections; the main fuel valve to fuel manifold connections; the connections on the start sphere repressurization line; the connections on the fuel manifold; the connections on the injector; and the two mainstage pressure switches to injector connections.

There were two leaks recorded during the leak check, as follows:

a. One leak at the J-2 engine interface on pipe assembly, P/N 1B52559-1 NC, required the replacement of the seal on the upstream side.

b. One leak at the thrust structure on pipe assembly, P/N 1B64384-1 NC, required the replacement of the seal and O-ring on the upstream side.

The following six revisions, described in the documentation log sheet, were written against the procedure:

a. One revision added steps to reset stage 4 to 250 +0, -25 psig, then vent the engine control bottle to 250 +0, -25 psig, to comply with Design Memorandum 190C.

b. One revision changed a step to note that the components within the pneumatic control package did not require a leak check unless requested by Propulsion Engineering. This was to clarify the leak check requirements.

c. One revision added instructions to the Post Test Instructions to differentiate when the post test instructions must be accomplished.

d. One variation revision was written to add a step to disconnect the $LH_2$ tank pressurization line at the flange between pipe assemblies, P/N's 1B43397-1 and 1B63355-1, in order to add a blanking flange and a hand valve to pipe assembly P/N 1B43397-1. This revision also capped pipe assembly P/N 1B63355-1 with suitable material to prevent contamination. This step is normally accomplished during the fuel tank pressure leak check and left for this procedure; however, the $LH_2$ tank pressurization line was reconnected to allow the stage to be removed from the tower to rework the cold helium spheres.

4.2.31 (Continued)

e. One variation revision added steps to connect flexible hoses from the control helium sphere and the control helium regulator discharge gauges to ports on the stage, and to install a length of tygon tubing on the dump outlet of the ambient helium fill module, of sufficient length to carry the gas out of the engine deck area. These steps were normally performed during the pneumatic control leak check, but were closed out to allow removal of the stage from the tower to rework the cold helium spheres.

f. One variation revision added steps to remove the flexible hoses and tygon tubing to return the stage to flight configuration. These steps were normally performed in the pneumatic control leak check procedure, but were included here because the stage was removed from the tower for rework of the cold helium spheres.

There were no parts short at the beginning of this test, and the system was signed acceptable by Engineering on 22 February 1967.

4.2.32 Hydraulic System Automatic (1B59485 D)

The purpose of the hydraulic system automatic test was to verify the integrity of the hydraulic system and verify system capability to provide engine centering and control during powered flight.

There were two runs made before the procedure was sold. The first run on 1 March 1967, was stopped because of computer interface unit problems. A second run on 6 March 1967, was successfully completed and sold, after correcting minor computer interface problems. The items verified in the test consisted of the auxiliary hydraulic pump/motor assembly, P/N 1A66241-507, S/N X454601; the hydraulic actuator assemblies, P/N 1A66248-505, S/N's 61 and 62; the main pump, P/N 1A86847-509, S/N 034; the engine pump, P/N 1A66240-503, S/N MX112311; and the accumulator/reservoir assembly, P/N 1B29319-519, S/N 00024.

There were no part shortages noted on the Engineering Comments sheet that affected this test procedure.

The hydraulic system automatic test was initiated, after the stage power setup procedure had been satisfactorily performed, by loading the appropriate hydraulic system STOL tape on the magnetic tape transport. The test number was then entered on the TOCC and the RESUME switch was depressed to initiate the test.

At the initiation of the test, measurements were taken of the hydraulic system in an unpressurized condition (see Test Data Table 4.2.32.1). The auxiliary hydraulic pump was then checked for operation in coast mode, flight mode, and manual mode. Each mode was successfully completed.

4.2.32 (Continued)

A test of the sine wave generator was performed, following the auxiliary hydraulic pump test, to ensure proper sine wave generator operation.

Upon completion of the sine wave generator test the engine centering test was performed. The engine centering test consisted of engine centering with actuator position locks on and the hydraulic system unpressurized; engine centering with actuator position locks removed, hydraulic system pressurized, and no excitation signal applied to the hydraulic actuators; and engine centering with actuator position locks removed, hydraulic system pressurized, and a zero excitation signal applied to the hydraulic actuators.

Clearance, linearity and polarity checks were performed after completing the engine centering tests. The clearance, linearity, and polarity checks were performed by extending and retracting the actuators to their stops (singly), causing the engine to move out to its extremes in travel in a counterclockwise direction as viewed from the engine bell.

The test verified polarity of command and response signals associated with the hydraulic servo engine positioning system. Application of a negative command to the pitch servo valve and a positive command to the yaw servo valve extended the actuators. The actuators were operated to move the engine from 0 degrees to 7 1/2 degrees through a square pattern and back to 0 degrees. A comparison of the actuator commands and the actuator position potentiometer measurement was made to verify actuator linearity. As the engine was sequenced through the square pattern a clearance check was made to verify there was no interference to engine motion within the gimbal envelope. The clearance, linearity, and polarity tests were successfully completed.

4.2.32 (Continued)

The next test performed was the transient response test. This test was executed by applying step command signals to the pitch and yaw actuator servomechanisms. The step commands moved the actuators from 0 degrees to -3 degrees, -3 degrees to 0 degrees, 0 degrees to +3 degrees, and +3 degrees to 0 degrees. The engine was observed visually and audibly for unwanted oscillations as well as the actuator response printout from the line printer. The transient response test was successfully completed (see Test Data Table 4.2.32.1).

After the transient response test, the data was reviewed and found acceptable, then the RESUME switch was depressed to shut down the system test. A zero condition command was executed and the system pressure, temperature, and fluid levels were checked and recorded. An engine centering command was then executed to ensure that the engine was centered. The auxiliary hydraulic pump automatic mode was turned off and the time recorded. All time/cycle significant items were recorded and the test was halted.

Post test procedures to remove and store tapes were performed. All end item logic power supply and/or prime power switches were set to the off or neutral position, as applicable. All non-end item prime power circuit breakers were set to the off position. All equipment was returned to the pretest condition.

The auxiliary hydraulic pump, P/N 1A66241-507, S/N X454601, is a time/cycle significant item and was cycled twice, with an elapsed time of 21 minutes, 24.572 seconds. Engine gimballing is a cycle significant item and was cycled one and one half times in the pitch plane, and one time in the yaw plane at 7.5 deg amplitude. The engine was also cycled one time in the pitch and yaw

4.2.32 (Continued)

plane at 3 deg amplitude. The switch selector was used fifty-four times. Elapsed time for the test was 37 minutes 9.533 seconds.

There were no FARR's noted during the running of the hydraulic system test; however, there were two revisions written. The two revisions were:

a. One revision added the digital events recorder, Model DSV-4B-289, P/N 1B39013-1, to the Mandatory End Item list and deleted it from the Optional End Item list because the recorder is a mandatory item required to record the test data.

b. One revision corrected a program error by reversing the upper and lower limits of the allowable engine actuator position in the square pattern.

It was noted, in the Engineering Comments, that the slew rates for the 3 degree transient response test were manually recalculated, because the slew rates printed out on the Line Printer Printout were incorrect. The correct values are reflected in Test Data Table 4.2.32.1.

The second test run was found acceptable for use after correcting the program errors and was signed off on 9 March 1967.

4.2.32.1 <u>Test Data Table, Hydraulic System Automatic</u>

<u>Hydraulic System - Unpressurized</u>

NOTE: There are no tolerances given for the hydraulic accumulator $GN_2$ pressure and temperature. They are used to calculate the $GN_2$ mass by the following formula: $\frac{GN_2 \text{ Pressure}}{GN_2 \text{ Temp} + 460} \quad 0.4326 = 1.925 \pm 0.200$ lbs.

The $GN_2$ mass is calculated for the unpressurized condition only. The hydraulic reservoir oil level, in the unpressurized condition only, must be correctable to more than 95 per cent by the formula RSVR level + [(124°F-RSVR Temp)(0.147)].

4.2.32.1 (Continued)

| Function | Measured Value | Limits |
|---|---|---|
| Hyd. Rsvr. Oil Press. | 78.56 psia | 50 psia min., 250 psia max. |
| Hyd. Acc. $GN_2$ Press. | 2372.81 psia | — |
| Hyd. Acc. $GN_2$ Temp. | 68.22 degrees | — |
| Hyd. Rsvr. Oil Level | 89.95 per cent | — |
| Hyd. Pump Inlet Oil Temp. | 68.23 degrees | 190 degrees max. |
| Hyd. Rsvr. Oil Temp. | 70.96 degrees | 124 degrees max. |
| Aft Bus 2 Current | -0.20 amps | — |
| $GN_2$ Mass | 1.942 lbs. | 1.925 ± 0.2 lbs. |
| Corrected Rsvr. Oil Level | 97.8 per cent | 95 per cent min. |

0 To -3 Degree Pitch Step Response - Engine Slew Rate 14.9 Deg/Sec.

| Time From Start (Seconds) | Pitch Excitation Signal (MA) | IU Pitch Act Pos Pot (Degrees) | 5 Volt Inst. Unit Voltage (Volts) |
|---|---|---|---|
| 0.000 | -0.050 | 0.180 | 5.039 |
| 0.028 | -19.922 | -0.591 | 5.034 |
| 0.056 | -19.873 | -0.952 | 5.034 |
| 0.084 | -19.873 | -1.370 | 5.029 |
| 0.112 | -19.922 | -1.817 | 5.029 |
| 0.141 | -19.873 | -2.250 | 5.034 |
| 0.169 | -19.775 | -2.640 | 5.039 |
| 0.197 | -19.775 | -2.899 | 5.029 |
| 0.225 | -19.775 | -3.059 | 5.034 |
| 0.253 | -19.873 | -3.116 | 5.039 |

-3 To 0 Degree Pitch Step Response - Engine Slew Rate 14.1 Deg/Sec.

| Time From Start (Seconds) | Pitch Excitation Signal (MA) | IU Pitch Act Pos Pot (Degrees) | 5 Volt Inst. Unit Voltage (Volts) |
|---|---|---|---|
| 0.000 | -19.850 | -3.270 | 5.039 |
| 0.026 | -0.098 | -2.784 | 5.034 |
| 0.055 | -0.098 | -2.438 | 5.034 |
| 0.083 | 0.000 | -2.034 | 5.039 |
| 0.111 | 0.000 | -1.615 | 5.024 |
| 0.140 | 0.098 | -1.183 | 5.034 |
| 0.168 | 0.000 | -0.778 | 5.034 |
| 0.196 | -0.098 | -0.461 | 5.039 |
| 0.225 | 0.000 | -0.259 | 5.034 |
| 0.253 | -0.098 | -0.188 | 5.034 |

4.2.32.1 (Continued)

0 To 3 Degree Pitch Step Response - Engine Slew Rate 14.0 Deg/Sec.

| Time From Start (Seconds) | Pitch Excitation Signal (MA) | IU Pitch Act Pos Pot (Degrees) | 5 Volt Inst. Unit Voltage (Volts) |
|---|---|---|---|
| 0.000 | 0.000 | -0.089 | 5.039 |
| 0.026 | 19.727 | 0.304 | 5.029 |
| 0.055 | 19.873 | 0.664 | 5.029 |
| 0.083 | 19.775 | 1.039 | 5.039 |
| 0.111 | 19.873 | 1.486 | 5.039 |
| 0.140 | 19.727 | 1.905 | 5.029 |
| 0.168 | 19.727 | 2.338 | 5.039 |
| 0.196 | 19.824 | 2.655 | 5.029 |
| 0.225 | 19.873 | 2.828 | 5.034 |
| 0.253 | 19.824 | 2.930 | 5.029 |

3 To 0 Degree Pitch Step Response - Engine Slew Rate 14.7 Deg/Sec.

| Time From Start (Seconds) | Pitch Excitation Signal (MA) | IU Pitch Act Pos Pot (Degrees) | 5 Volt Inst. Unit Voltage (Volts) |
|---|---|---|---|
| 0.000 | 19.800 | 3.090 | 5.039 |
| 0.027 | -0.098 | 2.612 | 5.029 |
| 0.055 | -0.098 | 2.280 | 5.034 |
| 0.084 | 0.000 | 1.876 | 5.034 |
| 0.112 | 0.000 | 1.443 | 5.029 |
| 0.140 | -0.146 | 0.953 | 5.034 |
| 0.168 | -0.098 | 0.606 | 5.034 |
| 0.196 | 0.000 | 0.289 | 5.034 |
| 0.225 | -0.098 | 0.087 | 5.024 |
| 0.253 | 0.000 | 0.044 | 5.029 |

0 To -3 Degree Yaw Step Response - Engine Slew Rate 16.3 Deg/Sec.

| Time From Start (Seconds) | Yaw Excitation Signal (MA) | IU Yaw Act Pos Pot (Degrees) | 5 Volt Inst. Unit Voltage (Volts) |
|---|---|---|---|
| 0.000 | 0.050 | -0.029 | 5.039 |
| 0.026 | -19.873 | -0.448 | 5.034 |
| 0.055 | -19.775 | -0.866 | 5.034 |
| 0.084 | -19.922 | -1.299 | 5.039 |
| 0.111 | -19-971 | -1.761 | 5.039 |
| 0.140 | -19.873 | -2.237 | 5.039 |
| 0.168 | -19.873 | -2.641 | 5.034 |
| 0.195 | -19.873 | -2.915 | 5.034 |
| 0.225 | -19.873 | -3.002 | 5.034 |
| 0.253 | -19.971 | -3.045 | 5.034 |

4.2.32.1 (Continued)

-3 To 0 Degree Yaw Step Response - Engine Slew Rate 16.6 Deg/Sec.

| Time From Start (Seconds) | Yaw Excitation Signal (MA) | IU Yaw Act Pos Pot (Degrees) | 5 Volt Inst. Unit Voltage (Volts) |
|---|---|---|---|
| 0.000 | -19.949 | -3.104 | 5.029 |
| 0.027 | 0.049 | -2.612 | 5.034 |
| 0.057 | 0.098 | -2.193 | 5.039 |
| 0.084 | 0.098 | -1.790 | 5.029 |
| 0.112 | 0.000 | -1.213 | 5.024 |
| 0.141 | 0.000 | -0.766 | 5.034 |
| 0.168 | 0.000 | -0.390 | 5.034 |
| 0.196 | 0.049 | -0.159 | 5.039 |
| 0.226 | 0.098 | -0.044 | 5.029 |
| 0.253 | 0.195 | 0.014 | 5.029 |

0 To 3 Degree Yaw Step Response - Engine Slew Rate 16.5 Deg/Sec.

| Time From Start (Seconds) | Yaw Excitation Signal (MA) | IU Yaw Act Pos Pot (Degrees) | 5 Volt Inst. Unit Voltage (Volts) |
|---|---|---|---|
| 0.000 | 0.100 | 0.060 | 5.034 |
| 0.027 | 19.775 | 0.533 | 5.039 |
| 0.055 | 19.727 | 0.908 | 5.029 |
| 0.084 | 19.873 | 1.370 | 5.039 |
| 0.112 | 19.727 | 1.875 | 5.034 |
| 0.140 | 19.873 | 2.309 | 5.039 |
| 0.169 | 19.824 | 2.697 | 5.029 |
| 0.197 | 19.775 | 2.899 | 5.029 |
| 0.225 | 19.824 | 2.986 | 5.029 |
| 0.253 | 19.873 | 3.029 | 5.029 |

3 To 0 Degree Yaw Step Response - Engine Slew Rate 16.0 Deg/Sec.

| Time From Start (Seconds) | Yaw Excitation Signal (MA) | IU Yaw Act Pos Pot (Degrees) | 5 Volt Inst. Unit Voltage (Volts) |
|---|---|---|---|
| 0.000 | 19.800 | 3.180 | 5.034 |
| 0.026 | 0.049 | 2.582 | 5.024 |
| 0.056 | 0.000 | 2.222 | 5.034 |
| 0.084 | 0.098 | 1.745 | 5.034 |
| 0.111 | 0.049 | 1.284 | 5.034 |
| 0.140 | 0.049 | 0.808 | 5.034 |
| 0.168 | 0.098 | 0.433 | 5.034 |
| 0.196 | -0.049 | 0.158 | 5.034 |
| 0.225 | 0.049 | 0.028 | 5.034 |
| 0.253 | -0.049 | 0.043 | 5.034 |

4 2.32 1 (Continued)

Hydraulic System Pressurized Actuator Locks Removed

(Pitch and Yaw excitation signal not applied to hydraulic actuators.)

| Function | Measured Value | Limits |
|---|---|---|
| Hyd. Sys. Press. | 3585.00 psia | 3500 min. |
| Hyd. Rsvr Oil Press | 172.39 psia | 50 psia min , 250 psia max. |
| Hyd. Acc. $GN_2$ Press | 3592.13 psia | — |
| Hyd. Acc. $GN_2$ Temp. | 74.88 degrees | — |
| Hyd. Rsvr Oil Level | 41.14 per cent | 8 per cent min |
| Hyd. Pump Inlet Oil Temp. | 119.70 degrees | 190 degrees max. |
| Hyd. Rsvr. Oil Temp. | 109.05 degrees | 124 degrees max. |
| Aft Bus 2 Current | 38 40 amps | 55 $\pm$ 30 |
| Pitch T/M Act Pos | 0.01 degrees | — |
| Pitch IU Act. Pos. | -0.09 degrees | — |
| Yaw T/M Act Pos. | 0 00 degrees | — |
| Yaw IU Actuator Position | 0.03 degrees | — |
| 5V Instrument Unit Voltage | 5.03 vdc | — |
| 5V aft Excitation Module Voltage | 5 01 vdc | — |
| Correct T/M Pitch Pos. | 0 035 degrees | -0.517 To 0 517 degrees |
| Correct IU Pitch Pos | -0 037 degrees | -0 517 To 0 517 degrees |
| Correct T/M Yaw Pos | -0.021 degrees | -0 517 To 0.517 degrees |
| Correct IU Yaw Pos | -0.021 degrees | -0.517 To 0 517 degrees |

4.2.33 Propellant Tanks System Leak Check (1B59432 B)

The purpose of the propellant tanks system leak check test was to verify the integrity of the S-IVB stage propellant tanks, the common bulkhead, and associated plumbing.

Items checked by this test procedure consisted of the LOX and $LH_2$ tank assembly, P/N 1A39303-543 S/N 2010; the LOX fill and drain valve, P/N 1A48240-505, S/N 115; the LOX prevalve, P/N 1A49968-509 Y, S/N 126; the LOX chilldown pump, P/N 1A49423-505, S/N 1390; the $LH_2$ fill and drain valve, P/N 1A48240-505, S/N 52; the $LH_2$ vent valve, P/N 1A48257-505, S/N 28; the $LH_2$ relief valve, P/N 1A49591-527, S/N 146; the $LH_2$ directional control valve, P/N 1A49988-1, S/N 7; the $LH_2$ prevalve, P/N 1A49968-501, S/N 121; the engine fuel feed ducts, P/N's 1A49320-503-003 and 1A49320-507, S/N's 23R and 41; and the $LH_2$ chilldown supply duct, P/N 1A49966-501 J, S/N 014.

This test procedure was active for 4 days between 1 March 1967 and 21 March 1967. The first test performed was the vacuum check of the jacketed ducts. The ducts were checked to a vacuum indication of 250 microns of mercury absolute. (See Test Data Table 4.2.33.1.) The second test performed was the common bulkhead leak check. The common bulkhead was pressurized to 2.5 $\pm$ 0.5 psig, then the common bulkhead disconnect assembly was checked for leakage. After checking for leakage, the common bulkhead was returned to an ambient pressure condition.

The LOX tank was pressurized to 2.5 psig in three stages. The first step pressurized the LOX tank to 1 psig, then a check was made, by listening for escaping gas, to determine the presence of leakage. The same procedure was followed at 2 psig and a 2.5 psig. After 2.5 psig was obtained, in the LOX

4.2.33 (Continued)

tank, the supply valve was closed and the LOX tank valves were leak checked, with a flowmeter, to determine leakage. (See Test Data Table 4.2.33.1.) After the tank valves were checked, a soap solution was applied to the LOX tank pipe assembly connections throughout the system, to find areas of leakage.

The $LH_2$ tank was next pressurized to 2.5 psig, in three stages, the same as the LOX tank was pressurized. At each stage of pressurization, a check was made to determine leakage. With 2.5 psig pressure in the $LH_2$ tank, the supply valve was closed and the $LH_2$ tank valves were leak checked, with a flowmeter, to determine leakage. (See Test Data Table 4.2.33.1) After the tank valves were checked for leakage, a soap solution was applied to the $LH_2$ tank pipe assembly connections, throughout the system, to find areas of leakage.

Excessive leakage (if any) found during leak check and the disposition of the leaks is given in Test Data Table 4.2.33.1. At completion of the leak check, both tanks were vented to atmosphere and the stage was returned to the flight configuration.

The LOX tank vent and relief valve, P/N 1A49590-513, was not installed at the beginning of the test. An interim use LOX tank vent and relief valve, P/N 1A49590-513-019, S/N 532, was installed for the test procedure. The vent and relief valve S/N 532 was to be replaced before static firing at STC.

4.2.33 (Continued)

There was one FARR, A196174, written during the operation of the procedure, to remove the sealing compound in the transducer port accomodation fitting, P/N 1B49262-1, for measurement D237. The excessive sealing compound was removed from fittings, P/N's 1B49262-1 and 1B29959-1. The rework was accepted for use.

There were five revisions written against the procedure. The five revisions were:

a. One revision deleted paragraphs 4.2.4, 4.2.5, and 4.2.6 of the procedure and rewrote them to make use of the existing helium facility which has a greater safety factor than the Heise Gage System formerly used.

b. One revision to allow troubleshooting of the common bulkhead lines and fittings deleted a revision dropping the requirement to pressurize the common bulkhead as it was impossible to pressurize it within a reasonable length of time.

c. One revision deleted the requirement to leak check the LOX tank pressure switches sensing lines between the tank and the hand valve as they were to be leak checked in the tower 8 checkout.

d. One revision deleted the requirement to remove the $LH_2$ and LOX fill and drain disconnect caps as it was not applicable. This revision also deleted the requirement to remove the flexible hoses from the $LH_2$ and LOX repress supply disconnects as they were removed during the umbilical disconnect procedure.

There were no modifications or EO's pending that would invalidate any portion of this test; therefore, no subsequent testing is contemplated. The propellant tank system was acceptable to Engineering for use and this test procedure was signed off on 22 March 1967.

4.2.33.1 Test Data Table, Propellant Tanks System Leak Check

Leakage:

Note: No leaks were found.

Valve Check:

| Part Number | Serial Number | Leakage Measurement |
|---|---|---|
| 1A48240-505 (LOX Fill & Drain) | 0115 | Main seal 1.6 scim. Blade Shaft Seal 0 scim. |
| 1A49968-509 Y (LOX Prevalve) | 126 | Shaft seal 0 scim. |
| 1A49423-505 Y (LOX Chilldown Pump) | 1390 | Cavity seal 0 scim. |
| 1A48240-505 ($LH_2$ Fill & Drain) | 0052 | Main seal 0 scim. Blade Shaft Seal 1.5 scim. |
| 1A48257-505 ($LH_2$ Vent Valve) | 0028 | Combined Main Seal 0 scim. |
| 1A49591-527 ($LH_2$ Relief Valve) | 146 | |
| 1A48257-505 ($LH_2$ Vent Valve) | 0028 | Combined Open & Closing Piston Seals 0 scim. Closing Piston Seals 1.45 scim. |
| 1A49988-1 ($LH_2$ Directional Valve) | 0007 | Shaft Seal 3.9 scim. |
| 1A49968-501 ($LH_2$ Prevalve) | 121 | Shaft Seal 0 scim. |

Vacuum Check:

| Part Number | Serial Number | Indication |
|---|---|---|
| 1A49320-507 (Eng. Fuel Feed Duct) | 23R | 125 microns mercury. |
| 1A49320-501 (Eng. Fuel Feed Duct) | 41 | 7 microns mercury. |
| 1A49966-501 ($LH_2$ Chilldown Supply Duct) | 014 | 60 microns mercury. |

4.2.34 Propulsion System Test (1B64390 D)

This automatic procedure performed the integrated electromechanical functional tests of the entire stage propulsion system. The procedure was divided into five sections, each of which was performed separately. The first section of the test checked the pressure switches for activation, deactivation, and proper control functions. The second section checked the pneumatic control system for functional capability and valve operation. The third section verified the operation of the LOX tank pressurization system. The fourth section verified the operation of the $LH_2$ tank pressurization system. The fifth section of the test was a four-part check of the J-2 engine spark ignition system, cutoff logic and delay timer, and engine control helium bottle and valves. The procedure involved all components of the stage propulsion system, including the J-2 engine.

Initiated on 2 March 1967, the procedure was completed on 6 March 1967, after 2 days of activity and accepted on 13 March 1967. The sections of the procedure are presented in order. Measurements made during the procedure are shown in Test Data Table 4.2.34.1.

Section one, the pressure switches test, was accomplished on 2 March 1967. For a helium transducer check, it was verified that the helium pressures, as measured through the AO and BO telemetry multiplexers, were 300 ± 60 psia for the ambient and cold helium spheres, and was 300 ± 20 psia for the control helium regulator discharge. A series of valve checks were made by opening and closing various valves, and verifying that the resulting pressure changes were within predetermined limits. The ambient helium sphere dump valve, the ambient supply shutoff valve, the cold helium dump valve and the cold helium supply shutoff valve all operated properly.

4.2.34 (Continued)

The proper operation of the LOX chilldown pump purge control valve, dump valve, and switch selector functions was also verified, as was the proper operation of the engine pump purge control valve and switch selector functions. For a check of the control and cold helium regulator backup pressure switches, the line and dome pressures, and the pickup and dropout pressures were measured. The pressure switch check was repeated twice, with measurements made of the line and dome pressures, and the switch pickup and dropout pressures. The switch selector was used 64 times during this section of the test. During the pressure switches test, a malfunction caused by the 5 volt power supply drifting a little high and pressure in the spheres a little high was remedied by readjusting the 5 volt power and lowering pressure in the spheres. Numeric readout values were verified to be within tolerance and the test was resumed.

Section two, the pneumatic control system test, was accomplished on 2 March 1967. For a check of the control helium valves, it was verified that the ambient helium sphere pressure was 700 $\pm$ 50 psia, as measured through the AO and BO multiplexers. The control helium sphere pressure and the control helium regulator discharge pressure were then measured. The $LH_2$ and LOX vent-valve operating times were measured, and then the valves were opened and boosted closed while the boost close times were measured. The LOX and $LH_2$ prevalve and chilldown shutoff valve operating times, and the $LH_2$ directional vent-valve operating times were measured.

For a switch selector check, the $LH_2$ and LOX vent valves, chilldown shutoff valves, and prevalves were individually commanded open and closed by the switch selector, and the proper response of each valve was verified. The switch selector was used 61 times during this section of the procedure.

4.2.34 (Continued)

Section three, the LOX tank pressurization system test, was accomplished by the second test run on 2 March 1967. A computer malfunction invalidated the first run. For the LOX tank pressure switch pickup and dropout check, the line and dome pressures, the pressure switch manifold pressurization and depressurization times, and the LOX ground fill pressure switch pickup and dropout pressures were measured.

The pressure switch pickup and dropout parts of the test were repeated twice, while measurements were made of the line and dome pressure, the manifold pressurization and depressurization times, and the LOX ground fill pressure switch pickup and dropout pressure, and deadband pressure range. The pressure switch deadband pressure range was determined as the difference in pickup and dropout pressures.

The switch selector functions and the operation of the heat exchanged bypass valve were verified by measuring the LOX pressure module helium gas pressure and the cold helium control valve inlet pressure when the bypass valve was closed and opened, respectively. In addition to the computer malfunction that invalidated the first run, a malfunction was generated by a loss of telemetry talkback caused by cable disconnects following a post checkout re-work. The cables were reconnected and a resume to retry passed o.k.

After the pressure switch tests were completed, the cold helium system was repressurized to 700 psia maximum, and the cold helium sphere pressure was measured. For the cold helium sphere blow-down and regulator test, the LOX pressure module helium gas pressure (plenum pressure) was verified to be be-tween 375 psia and 425 psia. Repeated measurements were then made of the

4.2.34 (Continued)

plenum pressure and the cold helium sphere pressure, until the sphere pressure dropped below 625 psia. The cold helium supply shutoff valve was then closed, completing the test. The switch selector was used 25 times during this test.

Section four, the $LH_2$ tank pressurization system test was accomplished by the second test run on 2 March 1967. The components of the $LH_2$ pressurization system were operated individually and the functional capability of each was verified. The parts tested included the $LH_2$ step pressure valve, the first burn bypass control valve, the switch selector first burn relay, and the switch selector $LH_2$ vent enable command.

Measurements were made of the line and dome pressures; the manifold pressurization and depressurization times; and the flight control, ground fill overpressure, and orbital coast vent high pressure switch pickup and dropout pressures. The pressure switch tests were repeated twice. The pressure switch deadband ranges were also determined, and are tabulated in Test Data Table 4.2.34.1.

It was noted that the $LH_2$ tank flight control pressure switch pickup was out of tolerance on the first of three runs. However, the value was acceptable since the average value of the three runs was 29.95 psia, within the allowable tolerance for the pressure switch.

Section five, the J-2 engine system test, was divided into four phases, each designed to test a specific engine operation: 1) the spark ignition system check, 2) the mainstage OK pressure switches check, 3) the control solenoid valves check, and 4) the engine sequence check.

4.2.34 (Continued)

Operation of the detection system 1 and 2 engine cutoff commands was verified as well as the $LH_2$ and LOX vent valves, prevalves, and chilldown valves. The engine ignition bus voltage, the control bus voltage, and the component test power voltages were measured. The spark ignition systems 1 and 2 were checked, and the start tank pressure changes were verified for proper vent valve operation. Operating times of the engine ignition timer delay, the helium delay time, the spark deenergize timer, and the start tank discharge timer were measured. Engine cutoff commands were checked and proper operation verified.

Mainstage OK pressure switches were checked while measurements were made of the GSE stage 6 and stage 2 line and dome pressures, and operation of mainstage OK pressure switch 1 and 2 pickup and dropout pressures was verified. The pressure switch check was repeated twice, and the pressures recorded.

The control solenoid valves check and the engine sequence check were run ten times as directed by NASA (Ref. I-CO-S-DAC-L-S9-67), to evaluate the main LOX valve second ramp opening time. The operating times in milliseconds for run 2 and 10 were 1830 and 1855 respectively. When evaluated by Rocketdyne field inspection as specified in the NASA request, the values obtained in all ten runs were acceptable.

It was noted in the Engineering Comments that runs 1 and 9 were to be disregarded, because the -240 strip chart was improperly set on run 1, and an amplifier circuit breaker on the -240 unit was accidently turned off on run 9. Consequently, two additional runs, 11 and 12, were made. Engineering evaluation of -240 strip chart data indicated that all four malfunctions typed out were within tolerance.

4.2.34 (Continued)

For the engine sequence check, the engine ignition bus power was turned on, the entire engine system was verified to be ready for the check, and the component test power was turned on. The engine sequence check was a completely automatic repetition of previous parts of the engine system test, where the necessary commands were given to cause engine start and engine cutoff, and the system responses to the commands were verified to be within the predetermined limits. Various operating times were measured during the sequence to verify the proper operation of the system component items. Since the program sequence looked at the gas generator valve telemetry talkback check instead of the hardwire terminal board, no time was calculated for the gas generator valve LOX poppet closed motion time. Analysis of the -240 recorded gas generator traces indicated actual times were in excess of the 10 millisecond minimum.

The measured positions and operating times of runs 2 and 10 (runs arbitrarily selected from the 12 control solenoid tests and engine sequence tests) are given in Table 4.2.34.1.

Engineering comments stated that all parts were installed at the start of this procedure. As noted, malfunctions and problems encountered during the test were corrected for subsequent test runs, and no failure and rejection reports were written against the procedure. A total of thirteen revisions were written during operation of the procedure. Nine were changes in procedure; three were variations in procedure; and one reflected a program error. The revisions were:

4.2.34 (Continued)

a. One revision deleted the Digital Events Recorder (DER) from the list of Optional End Items and added the DER to the list of Mandatory End Items.

b. One revision deleted item 2 in the $LH_2$ tank pressurization system test setup, disconnecting the $LH_2$ tank sense line pipe assembly 1B43820-1 from hand valve 1B53817-1. Item 3 was revised to connect a flexible hose (75 psig minimum) to the vehicle monitor port on 1B64043-1. Since the monitor port is now provided, no disconnect is required.

c. One revision was an addition to item 3 of the J-2 engine system test setup connecting the prevalve ground control port (-321) to the vent port on the prevalve actuation control module (404A43) with a flexible hose (75 psig minimum).

d. One revision simplified the J-2 engine test setup by revising item 1 to read: Disconnect pipe assembly (Rocketdyne P/N 106913) at tee on mainstage OK No. 1 pressure switch test port. Install cap assembly on tee.

e. One revision changed the checkout procedure to enable the use of the integrated test tape, which was not called out on the releasing EO.

f. One revision deleted a program statement to permit execution of a subsequent step.

g. One revision changed five sequential statements to provide time-in-range printout in hour-minute-second format.

h. One revision increased the tolerance from 430 to 435 psig on transducer D-105 to allow for system tolerance in the cold helium regulator test.

i. Four revisions were variations reflected in the narrative with their related Engineering comments.

It was not anticipated that this test would be invalidated by any modification or rework, and the propulsion system was accepted for use.

4.2.34.1 Test Data Table, Propulsion System Test

Section 1, Pressure Switches Test

| Function | Measured Value (psia) Test 1 | Test 2 | Test 3 | Limits |
|---|---|---|---|---|
| Stage 2 Line Pressure | 659.0 | 655.3 | 659.0 | 650 ± 25 |
| Stage 2 Dome Pressure | 673.9 | 673.9 | 673.9 | — |
| Cold He. PS Pickup Pressure | 467.1 | 464.6 | 462.1 | 467.5 ± 23.5 |
| Cold He. PS Dropout Pressure | 360.1 | 357.0 | 358.9 | 352.5 ± 23.5 |
| Control He. PS Pickup Pressure | 604.1 | 601.6 | 599.7 | 600 ± 21 |
| Control He. PS Dropout Pressure | 360.1 | 492.8 | 492.8 | 490 ± 31 |

Section 2, Pneumatic Control System Test

| Function | Measured Value (psia) | Limits (psia) |
|---|---|---|
| Control Helium Sphere Pressure | 720 | 700 ± 50 |
| Control He. Regulator Discharge Pressure | 554 | 515 ± 50 |

| Function | Operating Times (sec.) Open | Total Open | Close | Total Close | Boost | Total Boost |
|---|---|---|---|---|---|---|
| $LH_2$ Vent Valve | 0.021 | 0.113 | 0.202 | 0.412 | 0.080 | 0.205 |
| LOX Vent Valve | 0.021 | 0.128 | 0.124 | 0.334 | 0.064 | 0.220 |
| LOX Fill & Drain Valve | 0.121 | 0.261 | 0.660 | 1.885 | 0.374 | 0.853 |
| $LH_2$ Fill & Drain Valve | 0.172 | 0.336 | 0.876 | 2.509 | 0.471 | 1.003 |
| LOX Prevalve | 1.473 | 1.978 | 0.271 | 0.454 | - | - |
| $LH_2$ Prevalve | 1.274 | 1.901 | 0.226 | 0.406 | - | - |
| LOX CD Shutoff | 0.268 | 0.863 | 0.041 | 0.179 | - | - |
| $LH_2$ CD Shutoff | 0.215 | 0.798 | 0.021 | 0.162 | - | - |

| | Flight Pos. | Total Flight Pos. | Ground Pos. | Total Ground Pos. |
|---|---|---|---|---|
| $LH_2$ Directional Vent Valve | 0.057 | 0.182 | 0.149 | 0.284 |

Section 3, LOX Tank Pressurization System Test

Pressure Switch Check

| Function | Measured Value Test 1 | Test 2 | Test 3 | Limits |
|---|---|---|---|---|
| Stage 8 Line Pressure (psia) | 46.38 | 46.38 | 46.81 | 50 ± 5 |
| Stage 8 Dome Pressure (psia) | 52.76 | 51.91 | 52.76 | — |
| Manifold Press. Time (sec.) | 69.110 | 71.120 | 63.501 | — |
| Manifold Depress. Time (sec.) | 167.362 | 168.023 | 167.769 | — |

4.2.34.1 (Continued)

Pressure Switch Check (Continued)

| Function | Measured Value Test 1 | Test 2 | Test 3 | Limits |
|---|---|---|---|---|
| Ground Fill PS Pickup (psia) | 39.61 | 39.66 | 39.66 | 41 max. |
| Ground Fill PS Dropout (psia) | 37.46 | 37.57 | 37.51 | 36.5 min. |
| Ground Fill PS Range (psia) | 2.15 | 2.09 | 2.15 | 0.5 min. |

Heat Exchanger Bypass Valve Check

| Function | Bypass Closed (psia) | Bypass Open (psia) |
|---|---|---|
| LOX Press. Module He. Gas Press. | 278.63 | 182.07 |
| Cold He. Control Valve Inlet | 255.72 | 143.34 |

Cold Helium Regulator Test

| Function | Plenum Press. (psia) | He. Sphere Press. (psia) |
|---|---|---|
| Cold Helium Repressure. | | 739.88 |
| First Measurement | 428.11 | 713.16 |
| Second Measurement | 429.20 | 705.50 |
| Third Measurement | 429.74 | 686.41 |
| Fourth Measurement | 429.20 | 671.14 |
| Fifth Measurement | 431.38 | 655.86 |
| Sixth Measurement | 429.20 | 644.41 |
| Seventh Measurement | 428.65 | 629.13 |
| Eighth Measurement | 425.93 | 617.67 |

Section 4, $LH_2$ Tank Pressurization System Test

Pressure Switch Check

| Function | Measured Value Test 1 | Test 2 | Test 3 | Limits |
|---|---|---|---|---|
| Stage 7 Line Pressure (psia) | 46.59 | 46.59 | 47.55 | 50 ± 5 |
| Stage 7 Dome Pressure (psia) | 52.66 | 52.02 | 52.98 | — |
| Manifold Press. Time (sec.) | 94.149 | 88.021 | 87.556 | — |
| Manifold Depress Time (sec.) | 142.775 | 142.439 | 141.719 | — |
| PS System Final Press. (psia) | 39.30 | 39.35 | 39.30 | 39.0 min. |
| Flight Control PS Pickup (psia) | 30.01 | 29.90 | 29.95 | 30.0 max. |
| Flight Control PS Dropout (psia) | 27.68 | 27.68 | 27.73 | 26.5 min. |
| Flight Control PS Deadband (psia) | 2.32 | 2.22 | 2.22 | 0.5 min. |
| Gnd. Fill Overpress. PS Pickup (psia) | 32.90 | 32.90 | 32.74 | 34.5 max. |
| Gnd. Fill Overpress. PS Dropout (psia) | 30.88 | 30.88 | 30.94 | 30.8 min. |
| Gnd. Fill Overpress. PS Deadband (psia) | 2.01 | 2.01 | 1.81 | 0.5 min. |
| Orb. Coast Vent Hi PS Pickup (psia) | 35.38 | 35.43 | 35.38 | 35.00 ± 1.00 |
| Orb. Coast Vent Hi PS Dropout (psia) | 31.86 | 31.92 | 31.86 | 35.5 min. |

4.2.34.1 (Continued)

Valve Functional Check

| Valve Status | $GH_2$ Press. (psia) | Limit (psia) |
|---|---|---|
| Valves Open (A) | 58.64 | |
| Step Pressure Valve Closed (B) | 100.11 | (A) + 10 min. |
| First Burn Bypass Valve Closed (E) | 176.48 | (B) + 5 min. |
| First Burn Bypass Valve Open (H) | 101.20 | (E) - 10 max. |
| Step Pressure Valve Open (I) | 63.01 | (H) - 5 max. |

Section 5, J-2 Engine System Test

| Function | Measured Value | Limits |
|---|---|---|
| Engine Ignition Bus Voltage | 27.72 vdc | 27 ± 3 vdc |
| Engine Control Bus Voltage | 27.67 vdc | 27 ± 3 vdc |
| Component Test Power Voltage | 27.64 vdc | 27 ± 3 vdc |
| Start Tank Pressure | 54.47 psia | 40 psia min. |
| Engine Ignition Timer Delay | 0.434 sec. | 0.45 ± 0.03 sec. |
| Helium Delay Timer | 0.974 sec. | 1.0 ± 0.11 sec. |
| Sparks Deenergize Timer | 3.285 sec. | 3.3 ± 0.20 sec. |
| Start Tank Discharge Timer | 0.999 sec. | 1.00 ± 0.04 sec. |

Mainstage OK Pressure Switches Check

| | Measured Value (psia) | | | |
|---|---|---|---|---|
| Function | Test 1 | Test 2 | Test 3 | Limits (psia) |
| Stage 6 Line Pressure | 563.81 | 561.69 | 558.50 | 600 ± 50 |
| Stage 6 Dome Pressure | 569.14 | 570.19 | 565.94 | |
| Mainstage OK PS 1 Pickup | 520.50 | 519.89 | 519.27 | 515 ± 36 |
| Mainstage OK PS 1 Dropout | 445.63 | 446.74 | 446.24 | PU-62.5 ± 43.5 |
| Stage 2 Line Pressure | 573.39 | 569.67 | 569.67 | 600 ± 50 |
| Stage 2 Dome Pressure | 599.45 | 603.17 | 603.17 | |
| Mainstage OK PS 2 Pickup | 544.67 | 545.30 | 546.56 | 515 ± 36 |
| Mainstage OK PS 2 Dropout | 453.96 | 452.72 | 452.09 | PU-62.5 ± 43.5 |

| Control Solenoid Valves Check | Regulator Output Press. | | |
|---|---|---|---|
| | Run 1 | Run 10 | Limit |
| AO Multiplexer | 415.84 | 415.84 | 440 max. |
| BO Multiplexer | 415.84 | 415.84 | |

4.2.34.1 (Continued)

Control Solenoid Valves Check (Continued)

| Function | Measured Position (%) Run 2 | Run 10 | Limit (%) |
|---|---|---|---|
| Main $LH_2$ Valve Closed | 10.00 | 10.00 | 10 ± 10 |
| Main $LH_2$ Valve Open | 91.90 | 91.70 | 90 ± 10 |
| Main $LH_2$ Valve Reclosed | 10.20 | 10.20 | Closed ± 2 |
| Start Tank Disch. Valve Closed | 11.30 | 11.20 | 10 ± 10 |
| Start Tank Disch. Valve Open | 91.60 | 91.60 | 90 ± 10 |
| Start Tank Disch. Valve Reclosed | 11.40 | 11.40 | Closed ± 2 |
| Gas Generator Valve Closed | 10.20 | 10.30 | 10 ± 10 |
| Gas Generator Valve Open | 87.50 | 87.50 | 90 ± 10 |
| Gas Generator Valve Plateau | 45.20 | 45.20 | 65 max. |
| Gas Generator Valve Reclosed | 10.20 | 10.50 | Closed ± 2 |
| Main LOX Valve Closed | 9.20 | 9.50 | 10 ± 10 |
| Main LOX Vent 1st Ramp | 22.40 | 22.50 | |
| Main LOX Valve Open | 90.40 | 90.40 | 90 ± 10 |
| Main LOX Valve Reclosed | 9.40 | 9.50 | Closed ± 2 |
| LOX Turbine Bypass Valve Open | 90.00 | 90.20 | 90 ± 10 |
| LOX Turbine Bypass Valve Closed | 10.50 | 11.10 | 10 ± 10 |
| LOX Turbine Bypass Valve Reopened | 90.00 | 90.30 | Open ± 2 |

Engine Sequence Check

| Function | Run 2 Time (sec.) Start | Oper. | Total | Run 10 Time (sec.) Start | Oper. | Total |
|---|---|---|---|---|---|---|
| Ignition Phase Solenoid Talkback | - | 0.011 | - | - | 0.011 | - |
| Control He. Solenoid Talkback | - | 0.021 | - | - | 0.017 | - |
| ASI LOX Valve Open | - | 0.050 | - | - | 0.048 | - |
| Main $LH_2$ Valve Open | 0.082 | 0.049 | 0.131 | 0.079 | 0.057 | 0.136 |
| LOX Bleed Valve Closed | - | 0.066 | - | - | 0.098 | - |
| $LH_2$ Bleed Valve Closed | - | 0.074 | - | - | 0.069 | - |
| Start Tank Disch. Timer | - | 1.000 | - | - | 1.005 | - |
| Start Tank Disch. Valve Open | 0.099 | 0.108 | 0.207 | 0.096 | 0.104 | 0.200 |
| Mainstage Control Solenoid Energ. | - | 1.450 | - | - | 1.454 | - |
| Ignition Phase Timer | - | 0.450 | - | - | 0.449 | - |
| Start Tank Disch. Control Sol. Off | - | 0.006 | - | - | 0.007 | - |
| Main LOX Valve 1st Stage Motion | 0.051 | 0.056 | 0.106 | 0.051 | 0.051 | 0.102 |
| Start Tank Disch. Valve Closed | 0.098 | 0.264 | 0.361 | 0.093 | 0.260 | 0.353 |

4.2.34.1 (Continued)

Engine Sequence Check (Continued)

| Function | Run 2 Time (sec.) Start | Oper. | Total | Run 10 Time (sec.) Start | Oper. | Total |
|---|---|---|---|---|---|---|
| Gas Gen. Valve LOX Poppet | 0.144 | 0.057 | 0.112 | 0.134 | 0.063 | 0.115 |
| LOX Turbine Bypass Valve Close | 0.216 | 0.267 | 0.482 | 0.214 | 0.260 | 0.474 |
| Main LOX Valve 2nd Stage Motion | 0.655 | 1.823 | 2.479 | 0.660 | 1.851 | 2.511 |
| Spark System Off Timer | - | 3.300 | - | - | 0.007 | - |
| Ignition Phase Control Sol. Off | - | 0.007 | - | - | 0.007 | - |
| Mainstage Control Solenoid Off | - | 0.037 | - | - | 0.039 | - |
| ASI LOX Valve Closed | 0.031 | - | - | 0.032 | - | - |
| Main LOX Valve Closed | 0.047 | - | - | 0.049 | - | - |
| Main $LH_2$ Valve Closed | 0.086 | 0.220 | 0.306 | 0.083 | 0.223 | 0.306 |
| Gas Generator Valve Closed | 0.077 | 0.238 | 0.315 | 0.074 | 0.241 | 0.315 |
| Gas Generator Valve LOX Poppet Closed | 0.032 | - | - | 0.034 | - | - |
| LOX Turbine Bypass Valve Open | 0.255 | 0.501 | 0.756 | 0.262 | 0.500 | 0.762 |
| Control He. Sol. Deenerg. Timer | - | 0.979 | - | - | 0.984 | - |
| LOX Bleed Valve Open | 7.920 | - | - | 7.861 | - | - |
| $LH_2$ Bleed Valve Open | 8.545 from cutoff | | - | 8.55 from cutoff | | - |

### 4.2.35 All Systems Test (1B65533 A)

After all individual system checkouts were completed, the all systems test demonstrated the combined operation of the stage electrical, hydraulic, propulsion, instrumentation, and telemetry systems under simulated flight conditions. Where practical, the checkout followed the actual flight sequence of prelaunch operations, simulated liftoff, ullage firing, engine start, hydraulic gimballing, engine cutoff, coast period, attitude control, and stage shutdown.

The procedure was conducted twice, once for the umbilicals-in test, and once for the umbilicals-out test. During the umbilicals-in test, the umbilical cables were left connected during the entire procedure, to permit monitoring of the umbilical talkbacks, and to provide complete stage control for trouble shooting and safing operations. During the umbilicals-out test, the umbilical cables were ejected at simulated liftoff, to verify the proper operation of all on-board systems with the umbilicals disconnected. After the completion of the all systems test, with the umbilicals reconnected, the stage was shut down and completely reset to the proper condition for subsequent shipment to STC.

The all systems test was initiated on 13 March 1967, but was not completed at that time because of numerous malfunctions. Two attempts were made. The third attempt to perform the umbilicals-in portion of the test was successfully concluded on 14 March 1967, although there were some minor problems, which were acceptable. The common bulkhead pressure indication was printed out as an out-of-tolerance pressure; however, the data matched the DDT and was therefore accepted. The $LH_2$ ullage umbilical pressure indication was printed out at five steps, as an out-of-tolerance pressure, which was caused by an RFI condition; however, the pressure indications were acceptable. In the S22 to S21 backup

4.2.35 (Continued)

routine an E03 was received, DDAS out of synchronization, but the computer did not stop because it received the signal on the second try. Also, one cycle of the hydraulic actuator-yaw data was not recorded on the line printer and the Offner recorder.

One run was required to complete the umbilicals-out portion of the all systems test. This is recorded as the fourth run and was also performed on 14 March 1967, following the umbilicals-in test. The umbilicals-out portion of the test had the same malfunctions recorded as did the umbilical-in portion of the test mentioned above. In addition the ECO function did not indicate off when interrogated by the computer; however, it was off when checked on the numeric readout. The following discussion describes the all systems test without differentiating between umbilicals-in and umbilicals-out, except in those cases where an actual difference existed.

Before the all systems automatic procedure was started the GSE electrical systems and the stage propulsion system were manually set up for the test. A portion of the GSE setup was concerned with the measurement of the telemetry signal distribution unit calibration signal frequency. Initial conditions were then established, and the stage power setup test and engine pump purge sequence was conducted. The power setup test turned on power to the propellant utilization inverter and electronics, the EBW pulse sensors, the engine control bus and ignition bus, the APS buses and aft bus 2, and measurements were made of various currents and voltages, as shown in the Test Data Table. A switch selector register test completed the power setup.

The rate gyro was momentarily turned on, and the heater and sensor voltages were verified to be 28 $\pm$ 2 vdc. Pressure was measured for the ambient helium

4.2.35 (Continued)

sphere, the cold helium spheres, the engine control helium supply, and the control helium regulator discharge. The LOX chilldown pump purge and the engine pump purge were accomplished at an engine pump purge regulator pressure greater than 50 psia, completing the first part of the all systems test.

A series of valve and level sensor checks verified the proper operation of the LOX and $LH_2$ point level sensors, fast fill sensors, and overfill sensors, under simulated wet conditions. The simulated wet conditions were left on, to simulate loaded propellant tanks. Then switch selector control of the chilldown shutoff valves, the prevalves, and the vent valves, was verified. The LOX and $LH_2$ tank pressurization module helium gas pressure was measured. The proper operation of the fill and drain valves and the directional vent valve was also verified.

The EBW and telemetry checks verified the proper operation of the EBW pulse sensors, turned on the PCM RF assembly power and measured the forward bus 1 current. During the umbilicals-in test only, the forward bus 1 current was also measured while the telemetry RF silence was turned on. The telemetry calibration relay and the RACS were verified to operate properly. The telemetry antenna 1 forward power and the telemetry RF system reflected power and VSWR were measured. The static inverter-converter output voltages and operating frequency were measured. The engine cutoff command was turned on to complete this part of the all systems test.

The pitch and yaw actuator locks were removed and the hydraulic system was checked. The instrument unit substitute 5 volt power supply was turned on

4.2.35 (Continued)

and verified to be 5.0 $\pm$ 0.05 vdc. The hydraulic reservoir gaseous nitrogen mass and oil level were measured. With the hydraulic system unpressurized, the system functions were measured as shown in the Test Data Table. The hydraulic system was then pressurized using the auxiliary hydraulic pump, and the system functions were remeasured.

For the final prelaunch checks, the chilldown pump simulator cables were connected to receptacles 404A74A1J3 and 404A74A2J3 on the LOX and $LH_2$ chilldown inverters. The LOX and $LH_2$ chilldown pump currents were measured with the pumps turned ON. RF distribution system 2 was turned on, the control switch on the PCM ground station RF switch panel was set to open loop, and the ground station was verified to be synchronized.

A GSE 400 Hz calibration reference was used to measure the indication voltages for the LOX and $LH_2$ circulation pump flow rates and the static inverter-converter frequency; a GSE 100 Hz calibration reference was used to measure the LOX and $LH_2$ flowmeter voltage indications, and a GSE 1500 Hz calibration reference was used to measure the LOX and $LH_2$ pump speed voltage indications. Measurements were made of the common bulkhead pressure and its 20 and 80 per cent calibration voltage indications, the $LH_2$ ullage pressure and its 20 and 80 per cent calibration voltage indications, and the LOX ullage pressure. The telemetry antenna 1 forward power and the telemetry RF system reflected power and VSWR were measured, and a telemetry system RACS test was accomplished.

4.2.35 (Continued)

For the umbilicals-in test, the battery simulators were turned on, and the power bus voltages and electrical support equipment load bank voltages were measured. For the umbilicals-out test, the checkout batteries were turned on, and only the power bus voltages were measured. The $LH_2$ and LOX fast fill sensor wet conditions were turned off. The forward and aft power buses were transferred to internal, and the power bus voltages were again measured. The range safety receivers were transferred to internal power, and the low level signal strength indications were measured. The EBW ullage rocket firing unit disable was turned off, the safe and arm device was set to arm, the DDAS antenna input was turned on, and the receiver propellant dispersion cutoff command inhibit was turned off. Receipt of the PCM signal at the PCM and DDAS ground stations was verified. The cold helium supply shutoff valve was opened.

For the umbilicals-out test only, the power bus, receiver, and EBW firing unit external power was turned off, and the aft and forward umbilical cables were ejected and visually verified to be disconnected. The prelaunch checks terminated in the simulated liftoff.

Following the simulated liftoff, stage separation, APS, and engine start checks were conducted, starting with an automatic telemetry system calibration. The six ullage rocket ignition firing units were charged. The $LH_2$ and LOX prevalves were opened and closed, and the $LH_2$ chilldown pump was turned off. The fire ullage ignition command was turned on, and it was verified that the six ullage rocket ignition firing units responded properly. The aft separate simulation 1 and 2 were then turned on to simulate stage separation. The APS

4.2.35 (Continued)

firing enable command was turned on, and the instrument unit -28 vdc power was turned on and verified to be -28 $\pm$ 2 vdc. The APS roll attitude control checks were conducted by measuring the APS engine 1-1, 1-3 and 2-1, 2-3 valve open indications with the attitude control nozzle +Z+Y and -Z-Y commands turned on and off, and with the attitude control nozzle +Z-Y and -Z+Y commands turned on and off.

To initiate the engine start sequence, the LOX chilldown pump was turned off, the $LH_2$ and LOX chilldown shutoff valves were opened and closed, and the component test power was verified to be 28 $\pm$ 2 vdc. The engine cutoff command was turned off, the engine cutoff indications were verified to be OFF, and the engine ready indications were verified to be ON. The engine ready bypass and engine start commands were turned on, the engine start indication was verified to be ON, and the engine start command was turned off. The LOX flight pressure system, the $LH_2$ injector temperature detector bypass, the simulated ignition detection indication, the $LH_2$ first burn relay, and the simulated mainstage OK indication were all turned on. Verification was made that both engine thrust OK indications were OFF, both mainstage OK pressure switch indications were ON, the engine main LOX valve was OPEN, and the gas generator spark system indication was OFF. The LOX pressurization module helium gas pressure was verified to exceed 75 psia, the cold helium supply shutoff valve was closed, and the helium gas pressure was verified to be less than 50 psia. The propellant utilization system activate command was turned on. The charge ullage jettison and fire ullage jettison commands were turned on, and it was verified that the two ullage jettison firing units properly charged and fired. During the above part of the umbilicals-in test, additional

4.2.35 (Continued)

checks verified that the firing unit disable command properly prevented the ullage rocket ignition and jettison firing units from charging, and, if they were charged, properly discharged the units and prevented firing.

Following the engine start sequence, hydraulic gimbal and propellant utilization valve slew checks were conducted, starting with the step response gimbal and LOX valve slew checks. The propellant utilization system ratio valve position indication, and the hydraulic system pressure were measured, and the LOX bridge 1/3 checkout relay was turned on. A series of step response gimbal checks were conducted for 0 to -3 degrees, -3 to 0 degrees, 0 to +3 degrees, and +3 to 0 degrees, in both the pitch and yaw planes. As the results of these checks were compatible with the results of the same checks during the Hydraulic System Automatic procedure, H&CO 1B59485, (reference paragraph 4.2.32), the measured data is not repeated.

Following the gimbal sequence, the propellant utilization system ratio valve position indication was again measured, and the LOX bridge 1/3 checkout relay was turned off. A 0.6 Hz gimbal and $LH_2$ propellant utilization valve slew check was conducted next. The propellant utilization system ratio valve indication and the hydraulic system pressure were measured, and the $LH_2$ bridge 1/3 checkout relay was turned on. A 0.5 degree gimbal signal, at 0.6 Hz, was applied in the pitch and yaw planes. The engine position command currents and resulting instrument unit actuator piston positions were found to be within the required limits throughout the cycling in both planes, for both the umbilicals-in and umbilicals-out tests.

4.2.35 (Continued)

At the completion of the gimbal sequence, with the hydraulic system pressurized, the hydraulic system functions were measured, as shown in the Test Data Table. The propellant utilization system ratio valve position indication was verified to be greater than 3.5 vdc, the $LH_2$ bridge 1/3 checkout relay was turned off, and the ratio valve position indication was verified to be 2.65 $\pm$ 0.12 vdc.

The first burn, coast period, and engine cutoff checks were conducted next. The cold helium supply shutoff valve was opened, the LOX pressurization module helium gas pressure was verified to be greater than 75 psia, and the cold helium control valve inlet pressure was measured. The LOX system pressure switch supply was closed, the LOX prepressurization flight switch was verified to be OFF, and the cold helium control valve inlet pressure was again measured. The cold helium supply shutoff valve was closed, the LOX pressurization module helium gas pressure was verified to be less than 50 psia, the $LH_2$ prepressurization supply was opened, and the $LH_2$ tank pressurization module helium gas pressure was measured. This helium gas pressure was measured again with the $LH_2$ system pressure switch supply closed, and again after the $LH_2$ first burn relay was turned off. After that, the $LH_2$ prepressurization supply was closed. Then the point level sensor arm command was turned on, and the engine cutoff indication was verified to be OFF. The engine cutoff command was turned on, the engine cutoff indication was verified to be ON, and the engine cutoff command was turned off. The auxiliary hydraulic pump coast command was turned on, and the pump flight command was turned off. The number of gimbal cycles applied to the engine pitch and yaw planes during the tests, and the number of on/off cycles and the running time accumulated by the auxiliary hydraulic pump during the test, were all determined and recorded.

4.2.35 (Continued)

A series of checks conducted on the LOX and $LH_2$ point level sensors verified that a dry condition of any one LOX or $LH_2$ sensor would not cause engine cutoff, but that a dry condition of any two LOX sensors or any two $LH_2$ sensors would cause engine cutoff. The sensors were checked by turning off the simulated wet condition for the combinations of LOX sensors 1 and 2, 1 and 3, and 2 and 3, and $LH_2$ sensors 1 and 2, 1 and 3, and 2 and 3. During the umbilicals-in test only, the operating time of the LOX depletion engine cutoff timer was measured for each LOX sensor combination. The emergency detection system 1 and 2 engine cutoff commands were individually turned on, and it was verified that each command caused engine cutoff.

The final part of the all systems test was the range safety engine cutoff and propellant dispersion checks. A series of checks verified that the range safety EBW firing unit arm and engine cutoff command properly charged the range safety firing units and caused engine cutoff, and that the range safety propellant dispersion command properly fired the range safety EBW firing units to cause propellant dispersion. During the umbilicals-in test only, additional checks verified that the range safety 1 and 2 receiver propellant dispersion cutoff command inhibits properly prevented engine cutoff and EBW firing unit operation.

Following the propellant dispersion checks, the point level sensor arm command, the coast period command, the propellant utilization system activate command, and the propellant utilization inverter and electronics power, were all turned off. The range safety system off command was turned on, both range safety receiver low level signal strength indications were verified to be $0.0 \pm 0.3$ vdc, and the command was turned off.

4.2.35 (Continued)

An APS pitch sequence was started. The attitude control nozzle +ZP and -ZP commands were turned on, and the APS engine valve open indications were verified to be 4.3 ± 0.25 vdc for engine 1-2, and 4.1 ± 0.25 vdc for engine 2-2. The attitude control nozzle commands were turned off, and both engine valve open indications were verified to be less than 0.25 vdc. An APS yaw sequence was similarly conducted, using the attitude control nozzle +Z+Y and -Z+Y commands, and the +Z-Y and -Z-Y commands, while the APS engine 1-1, 1-3 and 2-1, 2-3 valve open indications were verified. A final telemetry system calibration was accomplished, completing the all systems test. The switch selector was used 110 times during the umbilicals-in test, and 185 times during the umbilicals-out test.

It was noted in the Engineering comments that the following interim use parts were installed on the stage for the purpose of stage checkout:

| Part Number | Name |
|---|---|
| 1A49590-513-019 | LOX Tank Relief Valve |
| 1A49988-1-001 | $LH_2$ Tank Directional Control Valve |
| NA5-27323T3 | Measurement C1 Transducer |
| NA5-27323T3 | Measurement C2 Transducer |
| NA5-27323T3 | Measurement C215 Transducer |

The interim use parts were to be removed and replaced by the flight critical parts prior to static firing at STC.

4.2.35 (Continued)

Notation was made in the Engineering Comments that the slew rates for the 3 degree transient response test were manually calculated to correct the line printer printout. These corrected values and a portion of the transient response data are shown in Test Data Table 4.2.32.1. The data in the all systems test and the data in the hydraulic system automatic test are comparable, therefore the test data in Test Data Table 4.2.32.1 will be used as representative of the data from the all systems test.

It was also noted in the Engineering Comments, with reference to revision 32, that the printouts of measurement D178 (43.5 psia and 43.6 psia) were correct because the 321 console, by numeric readout, was supplying very close to 43 psia. It was recommended that the test procedure be changed to enable a comparison to be made between the supply pressure and the pressure at the transducer, because the 321 console cannot characteristically repeatedly regulate low range pressure to the tolerances currently in the procedure. By knowing the supply pressure a more meaningful comparison of the transducer pressure readout can be made.

One FARR, A196175, was written to document the noise condition (in excess of 2 per cent) of measurements D-007 (LOX turbine inlet pressure) and D-0010 (gas generator chamber pressure), when the chilldown inverters were on This condition was acceptable to Engineering for use. It was also noted that measurement D184 ($LH_2$ tank non-propellant vent pressure) exhibited a 10 per cent dc offset when the telemetry transmitter was switched from closed loop to open loop. This measurement was accepted for use. It is one of a group that is scheduled for replacement starting with stage 212.

4.2.35 (Continued)

There were thirty-six revisions written against the procedure, one of which was voided. The remaining revisions follow:

a. One revision added the 1B43732-501 T/M GSE, Manual Check, PCM Ground Station drawing to the Applicable Documents list because it was referred to in a step.

b. One revision added drawing number 1B66461-505 to a step to clarify the step.

c. One revision corrected the H&CO number referred to in a step.

d. One revision changed the tolerance for the calibration signal frequency from ± 8 Hz to ± 1 Hz to agree with all systems requirements.

e. One revision changed the Not Equal amperage measurement for the aft 1 power supply current from 0 ± 3.0 amps to 2.7 ± 3.0 amps, because the aft 1 power supply will carry the current drawn by the EBW pulse sensors, which is approximately equal to 3 amps.

f. One revision added "Go to M118" following a halt, because the step was inadvertently omitted.

g. One revision increased the time delay from 50 milliseconds to 100 milliseconds before interrogation of the T/M submultiplexed channels because more time was required.

h. One revision changed the tolerance for the Not Equal Value of the Forward 1 Power Supply Current from ± .5 to ± 3 to establish the proper tolerance.

i. One revision added a breakpoint to verify nonprogrammed vehicle engine cutoff for proper verification of the ECO circuitry.

j. One revision changed the Go To instructions at statement 6005567 from M316 to step 5352 to make a new current measurement.

k. Nine revisions corrected program errors.

l. One revision changed a time delay from 100 milliseconds to 3 seconds to allow sufficient warmup time for the common bulkhead pressure and the $LH_2$ ullage pressure transducer amplifiers.

m. One revision changed the not equal statement from 58 ± 5 vdc to 60 ± 4 vdc to take into consideration the unloaded battery voltage.

4.2.35 (Continued)

n. One revision changed the not equal values at statements 6011277, 6011304, and 6011311 from 0 $\pm$ 1 to -0.8 $\pm$ 1, -1.6 $\pm$ 1, and -1.6 $\pm$ 1, respectively, because the low end of the pressure curves although equivalent to zero volts are not zero volts.

o. One revision changed two statements to expect ambient pressure (14.7 $\pm$ 1) under normal conditions to correct a procedural error.

p. One revision prevented updating the ignition counter unless an actual gas tube firing has occurred by setting a breakpoint to stop at statement 6013552 and using OSTOL to go to statement 6013553, where the resume button is depressed to continue the test.

q. One revision changed the instructions at statement 6014454 from Go To M663 to Go To step 14010 to update the ignition counter if a malfunction routine is entered.

r. One revision prevented updating the jettison counter unless an actual firing occurred by setting a breakpoint to stop at statement 6015502 and using OSTOL to go to statement 6015503, where the resume button is depressed to continue the test.

s. One revision added instructions to "remove and secure the DER data printout tape for post test analysis" to correct a procedural omission.

t. One revision deleted the number 1A66241-507 (auxiliary hydraulic pump) in one place, because it was listed twice in the second paragraph of the Running-Time/Cycle Record paragraph.

u. One revision changed the time delay of the common bulkhead and $LH_2$ ullage pressure transducer amplifiers from 100 milliseconds to 3 seconds to allow complete discharge before sensing for zero.

v. One variation revision changed the not equal pressure value at statement 6010335 from 14.7 $\pm$ .5 to 15 $\pm$ .5, because a comparison of the dummy curve to the vendor curve indicated that nominal pressure expected should be increased to 15.0 psia.

w. One variation revision altered the not equal pressure value at statements 6011637 and 6011642 from 49 $\pm$ 4 to 49, +4, -5.5, because the 321 pneumatic console cannot precisely regulate pressures in the low range.

4.2.35 (Continued)

x. One variation revision changed the tolerance on the $LH_2$ ullage pressure umbilical measurements, because the measurement is affected by noise from the PCM transmitter, when it is on. A constant noise voltage of about 0.4 volts causes a pressure reading increase of about 3.5 psia; therefore, the tolerance has been changed to allow for this condition.

y. One revision changed the instructions in the manual setup of the propulsion system to open the LOX isolation hand valve, rather than have it closed, in order to permit pressurization and checkout of the LOX tank ullage transducer, measurement D577.

z. One revision changed the time delay for the engine circuitry from 100 milliseconds to 1.25 seconds delay before ECO could be turned off, because the K-7 helium control solenoid was energized at the time ECO was to be turned off.

No further testing was to be done at the SSC VCL, and the all systems test was accepted. The stage was accepted.

4.2.35.1 Test Data Table, All Systems Test

| Function | Umbilicals-In | Umbilicals-Out | Limits |
|---|---|---|---|
| **Power Setup and Engine Pump Purge** | | | |
| Aft Bus 1 Current (Eng. Control Bus On) (amps) | 2.70 | 2.50 | 2 ± 3 |
| Engine Control Bus Voltage (vdc) | 27.75 | 27.72 | 28 ± 2 |
| Aft Bus 1 Current (Eng. Ig. Bus On) (amps) | 2.70 | 2.80 | 2 ± 3 |
| Engine Ignition Bus Voltage (vdc) | 27.75 | 27.69 | 28 ± 2 |
| Aft Bus 1 Current (APS Bus On) (amps) | 3.80 | 4.80 | 2 ± 3 |
| Aft Bus 2 Current (amps) | 0.20 | 0.00 | 5 max. |
| Aft Bus 2 Voltage (vdc) | 56.40 | 56.00 | 56 ± 4 |
| Amb. He. Sphere Press. D160 (psia) | 682.4 | 660.0 | 700 ± 50 |
| Cold He. Sphere Press. D016 (psia) | 709.3 | 678.8 | 700 ± 50 |

4.2.35.1 (Continued)

| Function | Umbilicals-In | Umbilicals-Out | Limits |
|---|---|---|---|
| Eng. Cont. He. Supply Press. D019 (psia) | 1072.2 | 1050.8 | 900 min. |
| Cont. He. Reg. Discharge Press. D014 (psia) | 552.5 | 552.5 | 515 ± 50 |
| **Valve and Level Sensor Checks** | | | |
| $LH_2$ Press. Reg. $GH_2$ Press. D104 (psia) | 63.01 | 60.83 | 40 min. |
| **EBW and Telemetry Checks** | | | |
| Forward Bus 1 Current (PCM RF On) (amps) | 4.899 | 4.200 | 4 ± 3.5 |
| Forward Bus 1 Current (TM Silence On) (amps) | 4.50 | * | ± 1 max. chg. |
| TM Antenna 1 Forward Power (watts) | 17.221 | 17.310 | 15 min. |
| TM System Reflected Power (watts) | 0.315 | 0.319 | 2 max. |
| TM System VSWR | 1.313 | 1.314 | 2 max. |
| Static Inv.-Conv. 115 volts (vac) | 114.28 | 114.32 | 115 ± 3.45 |
| Static Inv.-Conv. 5 volts (vdc) | 5.07 | 5.06 | 4.8 ± 0.3 |
| Static Inv.-Conv. 21 volts (vdc) | 21.55 | 21.56 | 21.25 ± 1.25 |
| Static Inv.-Conv. Frequency (Hz) | 399.25 | 396.84 | 400 ± 6 |
| **Hydraulic System Checks** | | | |
| Gaseous Nitrogen Mass (lb.) | 1.990 | 1.993 | 1.925 ± 0.2 |
| Reservoir Level (per cent) | 99.3 | 99.2 | 95.0 min. |
| Hydraulic System Unpressurized | | | |
| Hydraulic System Press. (psia) | 1382.13 | 1375.56 | ** |
| Accumulator $GN_2$ Press. (psia) | 2443.75 | 2462.88 | ** |
| Accumulator $GN_2$ Temp. (deg.) | 71.75 | 74.88 | ** |
| Reservoir Oil Temp. (deg.) | 77.23 | 79.58 | ** |
| Reservoir Oil Level (per cent) | 92.56 | 92.81 | ** |
| Reservoir Oil Press. (psia) | 79.87 | 80.30 | ** |

* Measurement Not Applicable
** Limits Not Specified

4.2.35.1 (Continued)

| Function | Umbilicals-In | Umbilicals-Out | Limits |
|---|---|---|---|
| Pump Inlet Oil Temp. (deg.) | 79.98 | 83.90 | ** |
| Yaw TM Actuator Position (deg.) | 0.86 | 0.86 | ** |
| Corrected Yaw TM Act. Pos. (deg.) | 0.840 | 0.840 | ** |
| Yaw IU Actuator Position (deg.) | 0.90 | 0.91 | ** |
| Corrected Yaw IU Act. Pos. (deg.) | 0.834 | 0.856 | ** |
| Pitch TM Actuator Pos. (deg.) | -0.14 | -0.21 | ** |
| Corrected Pitch TM Act. Pos. (deg.) | -0.120 | -0.184 | ** |
| Pitch IU Actuator Pos. (deg.) | -0.25 | -0.30 | ** |
| Corrected Pitch IU Act. Pos. (deg.) | -0.193 | -0.247 | ** |
| IU Substitute P5 Voltage (vdc) | 5.04 | 5.03 | ** |
| Aft 5v Excit. Mod. Volt. (vdc) | 5.01 | 5.01 | ** |
| Aft Bus 2 Current (amps) | 0.00 | * | |
| Aft C/O Battery 2 Current (amps) | * | -0.60 | ** |
| Hydraulic System Pressurized | | | |
| Hydraulic System Press. (psia) | 3585.00 | 3585.00 | ** |
| Accumulator $GN_2$ Press. (psia) | 3592.13 | 3592.13 | ** |
| Accumulator $GN_2$ Temp. (deg.) | 91.36 | 93.71 | ** |
| Reservoir Oil Temp. (deg.) | 77.23 | 80.76 | ** |
| Reservoir Oil Level (per cent) | 45.62 | 46.74 | ** |
| Reservoir Oil Press. (psia) | 169.77 | 170.64 | ** |
| Pump Inlet Oil Temp. (deg.) | 76.06 | 79.20 | ** |
| Yaw TM Actuator Position (deg.) | 0.05 | 0.02 | ** |
| Corrected Yaw TM Act. Pos. (deg.) | 0.026 | -0.005 | ** |
| Yaw IU Actuator Position (deg.) | 0.09 | 0.07 | ** |

* Measurement Not Applicable

** Limitis Not Specified

4.2.35.1 (Continued)

| Function | Umbilicals-In | Umbilicals-Out | Limits |
|---|---|---|---|
| Corrected Yaw IU Act. Pos. (deg.) | 0.030 | 0.030 | ** |
| Pitch TM Actuator Pos. (deg.) | 0.04 | 0.01 | ** |
| Corrected Pitch TM Act. Pos. (deg.) | 0.066 | 0.035 | ** |
| Pitch IU Actuator Pos. (deg.) | -0.09 | -0.09 | ** |
| Corrected Pitch IU Act. Pos. (deg.) | -0.030 | -0.045 | ** |
| IU Substitute P5 Voltage (vdc) | 5.04 | 5.03 | ** |
| Aft 5v Excit. Mod. Volt. (vdc) | 5.01 | 5.01 | ** |
| Aft Bus 2 Current (amps) | 39.00 | * | |
| Aft C/O Battery 2 Current (amps) | * | 0.00 | ** |
| Final Prelaunch Checks | | | |
| LOX Chilldown Pump Current (amps) | 20.00 | 20.80 | 20 ± 5 |
| $LH_2$ Chilldown Pump Current (amps) | 18.00 | 19.20 | 20 ± 5 |
| LOX Circ. Pump Flow Rate Indic. (vdc) | 3.866 | 3.871 | 3.836 ± 0.100 |
| $LH_2$ Pump Flow Rate Indic. (vdc) | 3.882 | 3.806 | 3.836 ± 0.100 |
| Static Inv.-Conv. Frequency Indic. (vac) | 2.666 | 2.677 | GSE ± 0.25 |
| LOX Flowmeter Indic. (vdc) | 1.671 | 1.677 | 1.667 ± 0.100 |
| $LH_2$ Flowmeter Indication (vdc) | 1.718 | 1.712 | 1.667 ± 0.100 |
| LOX Pump Speed Indication (vdc) | 3.199 | 3.194 | 3.125 ± 0.100 |
| $LH_2$ Pump Speed Indication (vdc) | 1.271 | 1.276 | 1.250 ± 0.100 |
| Common Bulkhead Pressure (psia) | 15.318 | 15.238 | 14.7 ± 0.5 |
| Common Bulkhead 20% Indication (vdc) | 1.045 | 1.020 | 1 ± 0.1 |
| Common Bulkhead 80% Indication (vdc) | 4.045 | 4.024 | 4 ± 0.1 |

* Measurement Not Applicable
** Limits Not Specified

4.2.35.1 (Continued)

| Function | Umbilicals-In | Umbilicals-Out | Limits |
|---|---|---|---|
| Common Bulkhead Press. Ambient (psia) | 15.292 | 15.292 | |
| $LH_2$ Ullage Pressure (psia) | 17.340 | 16.967 | 14.7 ± 0.5 |
| $LH_2$ Ullage 20% Indic. (vdc) | 1.300 | 1.364 | 1 ± 0.4 |
| $LH_2$ Ullage 80% Indic. (vdc) | 4.194 | 4.282 | 4 ± 0.4 |
| LOX Ullage Press. (psia) | 51.009 | 48.296 | 49 ± 4 |
| TM Antenna 1 Forward Power (watts) | 19.838 | 19.867 | 15 min. |
| TM System Reflected RF Power (watts) | 0.036 | 0.024 | 2 max. |
| TM System VSWR | 1.089 | 1.072 | 3 max. |
| Bus 4D30 Voltage (vdc) | 28.12 | 29.68 | 28 ± 2/ 29 ± 3 |
| Bus 4D20 Voltage (vdc) | 28.04 | 29.84 | 28 ± 2/ 29 ± 3 |
| Bus 4D10 Voltage (vdc) | 27.96 | 30.00 | 28 ± 2/ 29 ± 3 |
| Bus 4D40 Voltage (vdc) | 55.36 | 63.04 | 56 ± 4/ 60 ± 4 |
| Bus 4D20 ESE Load Bank (vdc) | 0.04 | * | 0 ± 1 |
| Bus 4D40 ESE Load Bank (vdc) | 0.08 | * | 0 ± 1 |
| Bus 4D30 ESE Load Bank (vdc) | 0.04 | * | 0 ± 1 |
| Bus 4D10 ESE Load Bank (vdc) | 0.08 | * | 0 ± 1 |
| Bus 4D31 Voltage, Int. (vdc) | 28.00 | 29.8 | 28 ± 2 |
| Bus 4D21 Voltage, Int. (vdc) | 27.56 | 28.48 | 28 ± 2 |
| Bus 4D11 Voltage, Int. (vdc) | 27.88 | 29.64 | 28 ± 2 |
| Bus 4D41 Voltage, Int. (vdc) | 54.56 | 58.96 | 56 ± 4 |
| Receiver 1 Low Level Signal Str. (vdc) | 3.55 | 3.46 | 2.5 min. |
| Receiver 2 Low Level Signal Str. (vdc) | 3.56 | 3.50 | 2.5 min. |
| <u>APS Checks</u> (Pre-Engine Start) | | | |
| APS Roll Attitude Control, +Z+Y and -Z-Y Commands | | | |
| Eng. 1-1 1-3 Ind., Cmd. On (vdc) | 4.112 | 4.276 | 4.3 ± 0.25 |
| Eng. 2-1 2-3 Ind., Cmd. On (vdc) | 3.979 | 4.102 | 4.1 ± 0.25 |
| Eng. 1-1 1-3 Ind., Cmd. Off (vdc) | 0.000 | 0.000 | 0.0 ± 0.25 |
| Eng. 2-1 2-3 Ind., Cmd. Off (vdc) | 0.010 | 0.000 | 0.0 ± 0.25 |
| APS Roll Attitude Control, +Z-Y and -Z+Y Commands | | | |
| Eng. 1-1 1-3 Ind., Cmd. On (vdc) | 4.092 | 4.245 | 4.3 ± 0.25 |

* Measurement Not Applicable

4.2.35.1 (Continued)

| Function | Umbilicals-In | Umbilicals-Out | Limits |
|---|---|---|---|
| Eng. 2-1 2-3 Ind., Cmd. On (vdc) | 3.974 | 4.102 | 4.1 ± 0.25 |
| Eng. 1-1 1-3 Ind., Cmd. Off (vdc) | 0.010 | -0.000 | 0.0 ± 0.25 |
| Eng. 2-1 2-3 Ind., Cmd. Off (vdc) | -0.005 | 0.005 | 0.0 ± 0.25 |
| Hydraulic Gimbal and PU Valve Slew Checks | | | |
| Step Response Gimbal Check | | | |
| PU Ratio Valve Pre-check Ind. (vdc) | 2.60 | 2.62 | 2.65 ± 0.12 |
| Hydraulic System Pressure (psia) | 35.82 | 35.92 | 3500 min. |
| PU Ratio Valve Post-Check Ind. (vdc) | 0.11 | 0.11 | 1.0 Max. |
| 0.6 Hz Gimbal Check | | | |
| PU Ratio Valve Pre-Check Ind. (vdc) | 2.53 | 2.56 | 2.65 ± 0.12 |
| Hydraulic System Press. (psia) | 3582 | 3582 | 3500 min. |
| Hydraulic System Functions, Pressurized | | | |
| System Pressure (psia) | 3578.44 | 3585.00 | ** |
| Accum. $GN_2$ Pressure (psia) | 3597.56 | 3597.56 | ** |
| Accum. $GN_2$ Temperature (deg.) | 77.23 | 78.02 | ** |
| Reservoir Oil Temperature (deg.) | 120.49 | 117.33 | ** |
| Reservoir Oil Level (per cent) | 46.74 | 46.99 | ** |
| Reservoir Oil Pressure (psia) | 173.26 | 173.26 | ** |
| Pump Inlet Oil Temp. (deg.) | 129.96 | 127.99 | ** |
| Yaw TM Actuator Position (deg.) | 0.05 | 0.00 | ** |
| Corrected Yaw TM Act. Pos. (deg.) | 0.026 | -0.021 | ** |
| Yaw IU Actuator Position (deg.) | 0.04 | 0.06 | ** |
| Corrected Yaw IU Act. Pos. (deg.) | -0.008 | 0.008 | ** |
| Pitch TM Actuator Pos. (deg.) | 0.03 | 0.01 | ** |
| Corrected Pitch TM Act. Pos. (deg.) | 0.051 | 0.035 | ** |
| Pitch IU Actuator Position (deg.) | -0.07 | -0.09 | ** |

** Limits Not Specified

4.2.35.1 (Continued)

| Function | Umbilicals-In | Umbilicals-Out | Limits |
|---|---|---|---|
| Corrected Pitch IU Act. Pos. (deg.) | -0.022 | -0.037 | ** |
| IU Substitute P5 Voltage (vdc) | 5.03 | 5.03 | ** |
| Aft 5v Excit. Mod. Volt. (vdc) | 5.01 | 5.01 | ** |
| Aft Bus 2 Current (amps) | 40.00 | * | |
| Aft C/O Battery 2 Current (amps) | * | 38.60 | ** |
| First Burn, Coast Period, and Engine Cutoff | | | |
| Cold Helium Control Valve Inlet Pressure | | | |
| Cold Helium Supply Open (psia) | 194.62 | 164.61 | ** |
| LOX Press. Switch Supply Closed (psia) | 74.60 | 61.51 | ** |
| $LH_2$ Tank Press. Module $GH_2$ Pressure | | | |
| $LH_2$ Prepress. Supply Open (psia) | 184.12 | 164.48 | ** |
| $LH_2$ Press. Switch Supply Closed (psia) | 113.20 | 97.92 | ** |
| $LH_2$ First Burn Relay Off (psia) | 64.10 | 61.92 | ** |
| Engine Gimbal Cycles | | | |
| Pitch Plane 7 Degrees | 0.00 | 0.00 | ** |
| Pitch Plane 3 Degrees | 1.00 | 1.00 | ** |
| Yaw Plane 7 Degrees | 0.00 | 0.00 | ** |
| Yaw Plane 3 Degrees | 1.00 | 1.00 | ** |
| Auxiliary Hydraulic Pump On/Off Cycles | 1 | 1 | ** |
| Auxiliary Hydraulic Pump Run Time | 52 min 0.476 sec | 43 min 54.509 sec | ** |
| Ullage Firing Unit Cycles | 1 | 1 | ** |
| Jettison Firing Unit Cycles | 1 | 1 | ** |
| RS Firing Unit Cycles | 1 | 1 | ** |
| LOX Bridge R1 Cycles | 1 | 1 | ** |
| $LH_2$ Bridge R2 Cycles | 1 | 1 | ** |

* Measurement Not Applicable
** Limits Not Specified

## 4.3 Propellant Tanks System Leak Test (A659-1B65763-1PATP6)

Subsequent to the removal of the stage from the VCL tower on 22 March 1967, this production acceptance test procedure was performed to establish the leak-free condition of the propellant tanks assembly. The leak test was conducted, in VCL tower 8, prior to the final inspection of the stage.

Preliminary to this procedure, setup and hookup test A659-61808-PATP3 was conducted on 31 March and 3 April 1967. This began with gas samples taken from all lines, to ensure system cleanliness. The installation of all necessary cables and sensors followed, as modified by the following six revisions:

a. One revision was written to change the cable installed at the forward skirt umbilical, from 404W2J1 to 411W2J1.

b. One revision was written to change the hookup location for the high pressure gas supply line, from pipe assembly, P/N 1B52505-1, to pipe assembly, P/N 1B64811-1; however, a subsequent revision changed the pipe assembly from P/N 1B64811-1 to P/N 1B66420-1.

c. One revision was written to change the stage regulator outlet pressure pipe assembly, from P/N 1B52489-1 to P/N 1B67224-1.

d. One revision was written to change the connection point for a flex pressure sense line from the stage checkout valve, P/N 1B53817, to the pipe tee P/N 1B67145-1.

e. One revision added the following note to the step that installed the pressure adapters on the vent thrust nozzle flanges: A 1 in. flex hose may be substituted as required for part of this hardline assembly.

These were the only revisions to the hookup procedure.

The sensor and cable installation was followed by installation of adapters, and hookup of all lines. Protective caps and the desiccant assembly were removed. The preliminary setup procedure was accepted by Engineering on 4 April 1967.

4.3 (Continued)

On 3 April 1967, the tanks leak check was begun. The first step was to verify the system setup per the above procedure. The tanks were pressurized with gaseous helium, to permit the use of the USON leak detector in establishing their integrity. The integrity pressures for the LOX tank was 12.2 psig and the $LH_2$ tank was 12.3 psig. The pressures had decreased to 11.0 psig for the LOX tank and 11.8 psig for $LH_2$ tank, after 10 minutes had elapsed. The LOX and $LH_2$ tanks were then exhausted to 0.5 psig through the $GH_2$ and $GO_2$ valves.

The LOX and $LH_2$ tanks were then repressurized to 10.2 psig for the leak test. It was verified that the helium concentration in the tanks was 50 per cent or greater. The results of this check appear in Test Data Table 4.3.1. The USON leak detector was used to ensure the proper helium concentration. The LOX and $LH_2$ tank pressure gauges were monitored throughout the test, and it was required that any pressure decrease of greater than 0.5 psig be reported.

The following areas in the LOX system were checked by the USON leak detector method for any leakages in excess of 0.001 cubic centimeters per second: the LOX tank to prevalve connection; the feed line from the prevalve to the engine interface, including transducers C004 and D003, the chilldown line from chilldown pump to prevalve; the chilldown return line from the engine interface to the tank; the fill and drain line from aft umbilical disconnect to tank, the vent line from tank to aft skirt, the sense lines from tank to transducers D180, D179, and D577 (including hand valve, P/N 1B53817), the pressurization line from tank to pipe assembly, P/N 1B55285-1; the tank wiring feedthrough assembly, the instrumentation feedthrough assembly, and the PU probe feedthrough assembly. All of the above lines met the standard of $10^{-3}$ cc/sec leakage.

4.3 (Continued)

A flowmeter was used to verify that the LOX fill and drain valve and prevalve shaft seal leakage were less than 100 scim, and that the LOX chilldown pump cavity seal leakage was less than 25 scim. It was also confirmed that the relief valve housing static seal leakage was less than 1 scim, and that the vent and relief valve from pilot valve cap to duct leakage did not exceed 80 scim.

The USON detector was next employed to verify that the following areas in the $LH_2$ system did not leak in excess of 0.001 cubic centimeters per second. the feed line from tank to prevalve; the feed line from prevalve to engine interface, including transducers C003 and D002, the $LH_2$ chilldown and return lines from pump to prevalve, and from engine interface to tank, the fill and drain line from aft umbilical disconnect to tank; the vent lines from tank to directional control valve, the vent line from directional control valve to forward umbilical disconnect; the vent line from directional control valve to the capped ends of nonpropulsive and continuous vent systems, sense lines from tank to transducers D576, D177, and D178; the pressurization line from tank to pipe assembly, P/N 1B43397-1, and the PU probe feedthrough assembly, the cover plate, and the tank to cold helium bottle connections.

The flowmeter was used to check the $LH_2$ system valves leakage as follows· fill and drain valve and prevalve shaft seal leakage was verified less than 100 scim, directional control valve shaft seal leakage was checked less than 5 scim; $LH_2$ relief pilot valve seals and vent valve static seals leakage was determined to be less than 40 scim, the relief valve static seal leakage was determined to be less than 1 scim, and the chilldown pump housing seal leakage was verified less than 25 scim.

4.3 (Continued)

The vent and non-propulsive vent valves were closed, the sample bleed valve was opened, the directional control valve was set to "flight," and the continuous vent valve was set to "relieve." The sample port leakage was measured with a flowmeter, and was found to be less than 330 scim. The closing of both systems fill and drain and vent valves completed the leak test.

A disconnect and tank securing procedure was then followed. The desiccant unit was installed, all lines were removed, valves were closed, and protective caps were replaced. The helium bleed valve was opened, and the system was allowed to bleed to ambient (unmeasurable GHe concentration). All switches were turned off.

The following six items were changed according to revisions appearing in the Quality Engineering documentation log sheet:

a. One revision was written to allow 15 minutes to elapse before opening the sample valves at the start of the leak test.

b. One revision changed the "Leak Test and Vent switch $S_2$" to "Warning lights off," for the retest portion of the leak test.

c. One revision deleted the step to set "Switch $S_1$ - Complete Stage."

d. One revision added a step in the retest portion of the leak test to, "Depressurize $LH_2$ tank, fix leak, and hold LOX tank at 10 $\pm$ 0.5 psi."

e. One revision added a step to, "Repressurize the $LH_2$ tank to 10 $\pm$ 0.5 psi and leak check repaired area after taking samples on $LH_2$ tank."

f. One revision was written to, "Disconnect the high pressure gas supply line from the 1B66420-1 pipe assembly, reconnect pipe fitting and connect supply line to monitor port on 1B65099-1 pipe assembly. Leak check 1B66420-1 pipe assembly fitting with USON leak detector and bubble solution with 750 psi pressure (He)."

4.3 (Continued)

One FARR, A228582, was written to replace seals or retorque B-nuts, as required, to correct the leaks found during the leak check, and to retest those items that had failed. The location of the leaks and the parts involved with the remedial action are noted in Test Data Table 4.3.1.

4.3.1 Test Data Table, Propellant Tanks Leak Test

Gaseous Helium Concentration Prior to USON Leak Tests (S/B greater than 50 per cent)

| Location | GHe Concentration (per cent) Test | Retest |
|---|---|---|
| LOX Fill and Drain Line | 76.7 | 88.6 |
| LOX Chilldown Return Lines | 76.0 | 88.5 |
| $LH_2$ Tank Non-Propulsive Vent Line | 100.0 | 100.0 |
| LOX Tank Vent Port | 95.6 | 100.0 |
| $LH_2$ Chilldown Return Lines | 64.9 | 97.2 |
| $LH_2$ Fill and Drain Line | 67.2 | 97.3 |
| $LH_2$ Monitor Port | 99.8 | 100.0 |
| $LH_2$ Chilldown and Return Port | 100.0 | — |

Leaks

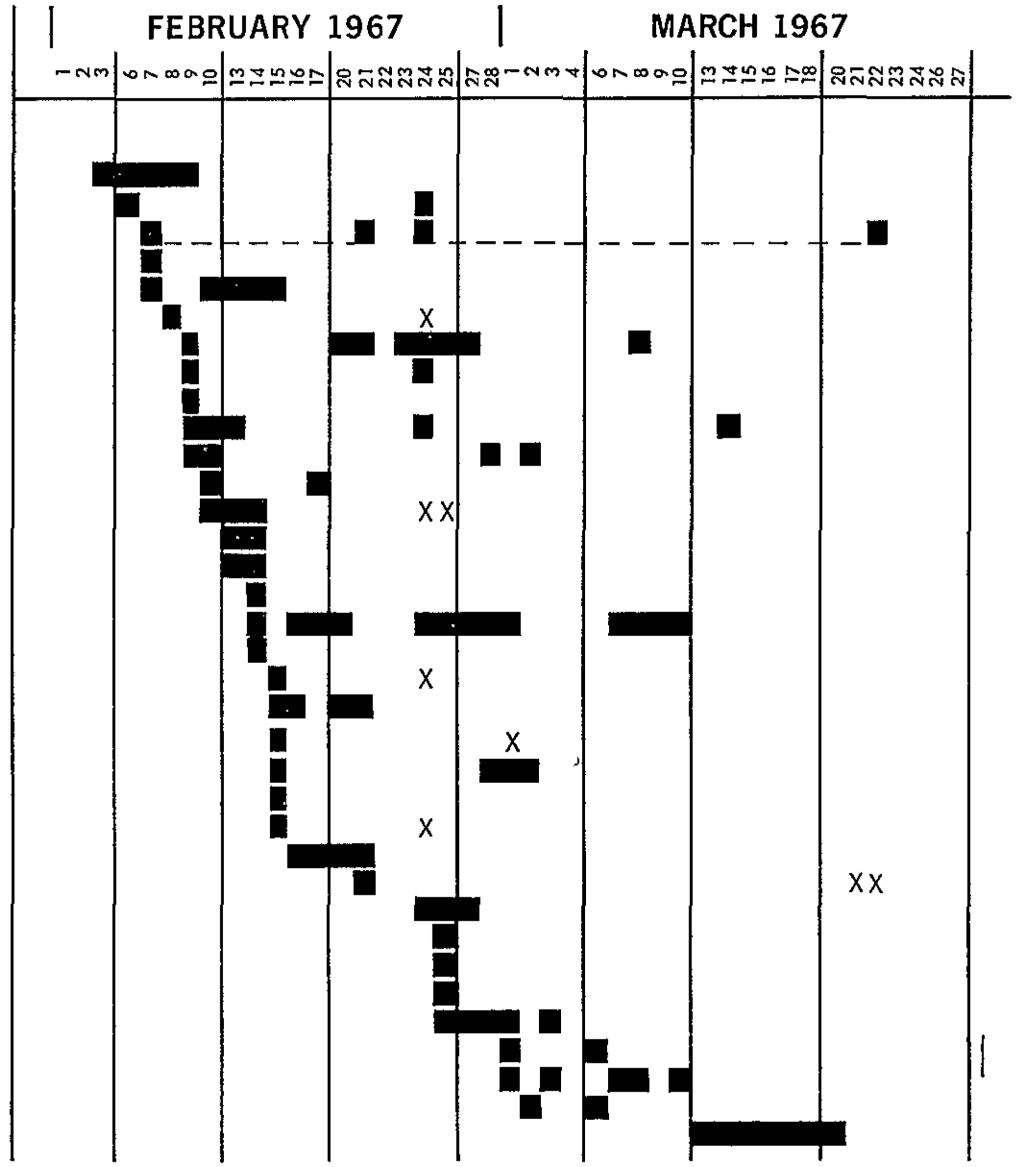
| P/N | Name/Location | Remedy |
|---|---|---|
| 1A49320-507 | Fuel Duct/$LH_2$ prevalve to engine | Replace seal |
| 1A77116-1 | Elbow/LOX vent aft skirt | Replace seal |
| 1A94469-503 | Duct/$LH_2$ tank to vent valve | Replace seal |
| 1B64115-1 | Pipe Assembly/$LH_2$ tank forward dome | Replace seal |
| 1B64127-1 | Pipe Assembly/LOX aft dome | Retorque B-nut |
| 1B64864-1 | Pipe Assembly/$LH_2$ tank forward skirt | Retorque B-nut |

## 5.0 POSTRETENTION

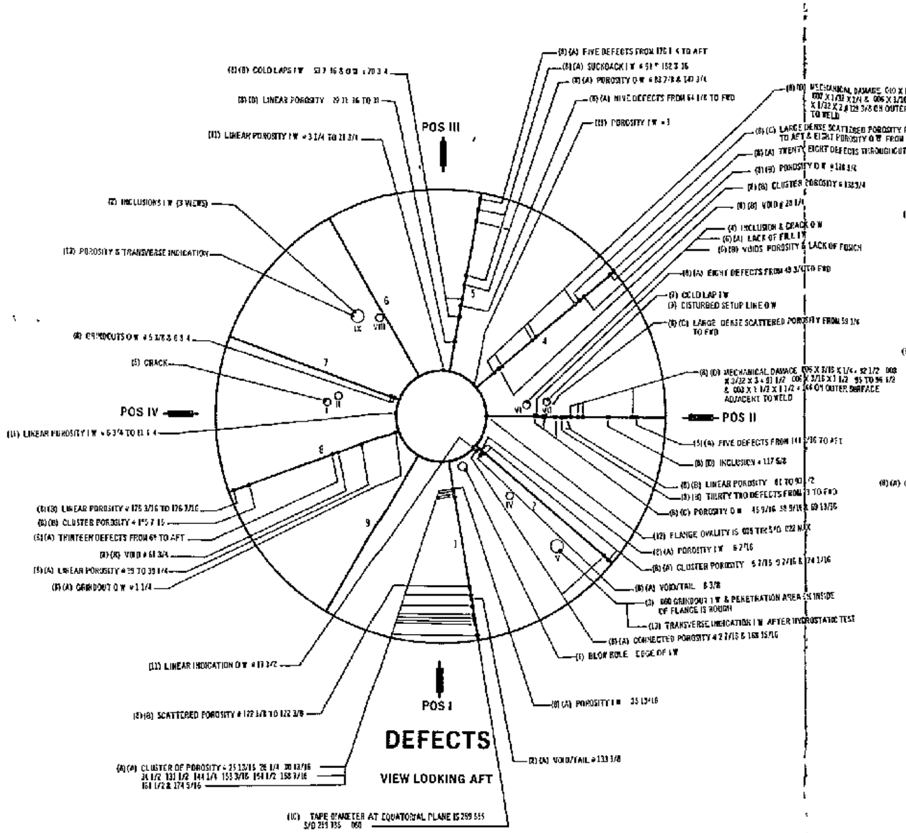
This section to be added 21 days after stage shipment from SSC to STC.

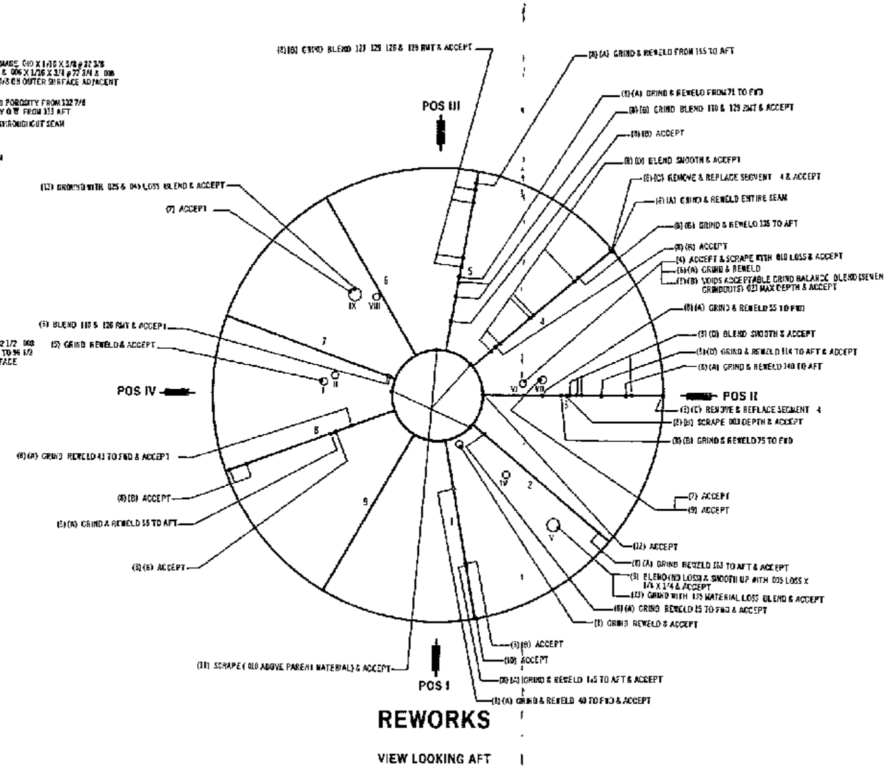
# 210 SSC VCL TESTING SEQUENCE

| PARA | | PROCEDURE |
|---|---|---|
| 4 2 1 | 1B59763 | CONT COMPAT CHECK |
| 4 2 2 | 1B41926 | FWD SKIRT T/C CHECKOUT |
| 4 2 3 | 1B42124 | FWD SKIRT T/C OPERATION |
| 4 2 4 | 1B39095 | ENGINE ALIGNMENT PROC |
| 4 2 5 | 1B66927 | T/M & RS ANTENNA SYST |
| 4 2 6 | 1B59818 | CRYO TEMP SENSOR VERIF |
| 4 2 7 | 1B40973 | HYD SYST FILL & BLEED |
| 4 2 8 | 1B40544 | AFT SKIRT & INTERST PURGE |
| 4 2 9 | 1B59768 | UMB I/F COMPAT CHECK |
| 4 2 10 | 1B59590 | STAGE PWR SETUP |
| 4 2 11 | 1B59591 | STAGE PWR TURNOFF |
| 4 2 12 | 1B59822 | SIGNAL COND SETUP |
| 4 2 13 | 1B59821 | LEVEL SENSOR SETUP |
| 4 2 14 | 1B59823 | DDAS CALIB , MAN |
| 4 2 15 | 1B59593 | DDAS CALIB , AUTO |
| 4 2 16 | 1B59427 | PROP SYST COMPAT |
| 4 2 17 | 1B59594 | DDAS AUTO CHECKOUT |
| 4 2 18 | 1B66929 | PROP COMP INT LEAK CHK |
| 4 2 19 | 1B59592 | PWR DISTRIBUTION SYST |
| 4 2 20 | 1B59429 | $LH_2$ TANK PRESS LEAK CHK |
| 4 2 21 | 1B59826 | PU SYS CALIBRATION |
| 4 2 22 | 1B59481 | PROP UTILIZATION SYS |
| 4 2 23 | 1B59601 | AUX PROPULSION SYSTEM |
| 4 2 24 | 1B59597 | EXPLOD BRIDGEWIRE SYS |
| 4 2 25 | 1B59430 | PNEU CONT SYS LEAK CHK |
| 4 2 26 | 1B62965 | FWD SKIRT T/C SECURING |
| 4 2 27 | 1B59431 | COLD HE SYS LEAK CHK |
| 4 2 28 | 1B59829 | RS RECEIVER MAN OPERS |
| 4 2 29 | 1B59596 | RS RECEIVER CHECKS |
| 4 2 30 | 1B59482 | RANGE SAFETY SYSTEM |
| 4 2 31 | 1B59433 | J2 ENGINE LEAK CHECK |
| 4 2 32 | 1B59485 | HYD SYSTEM AUTO |
| 4 2 33 | 1B59432 | PROP TANK SYS LEAK CHK |
| 4 2 34 | 1B64390 | PROPULSION SYS TEST |
| 4 2 35 | 1B65533 | ALL SYSTEMS TEST |



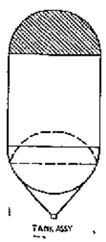

X INDICATE SECOND ISSUE




LEGEND

I BRACKET TEE
II INSTR LEAD OUT WIRE PORT
III VENT SEPARATOR
IV CLIP LH VENT LINE
V VENT LINE PORT
VI PRESS SENSOR
VII PRESS PORT
VIII BRACKET TEE
IX PIC LIFE LEAD OUT PORT




| ITEM | FARR NUMBER | INITIATION DATE | DEFECTS | REWORKS REQUIRED | HOW REWORKED | REWELDS |
|---|---|---|---|---|---|---|
| (1) | A220546 CC | 9-6-66 | 1 | 1 | AUTO TIG | 1 |
| (2) | A220523 EE | 9 7 66 | 3 | 4 | N/A | 0 |
| (3) | A220573 FF | 9 12 66 | 2 | 2 | N/A | 9 |
| (4) | A223448 DD | 9 20-66 | 2 | 1 | N/A | 0 |
| (5) | A223449 HH | 9-21 66 | 1 | 1 | AUTO TIG | 1 |
| (6) | A223450 DD | 9 23 66 | 11 | 8 | AUTO TIG | 1 |
| (7) | A223467 DD | 10-1-66 | 1 | 0 | N/A | 0 |
| (8) | A223494 MER | 10-3-66 | 164 | 14 | AUTO TIG | 16 |
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| ITEM | FARR NUMBER | INITIATION DATE | DEFECTS | REWORKS REQUIRED | WELDING REWORK | REWELDS |
|---|---|---|---|---|---|---|
| (9) | A151020 DD | 10-18 66 | 1 | 0 | N/A | 0 |
| (10) | A150976 TAPE | 10-24-66 | 1 | 0 | N/A | 0 |
| (11) | A151043 FL | 10-23-66 | 4 | 4 | N/A | 0 |
| (12) | A150587 AA | 10-29 66 | 1 | 0 | N/A | 0 |
| (13) | A270497 EE | 11 19-66 | 3 | 3 | N/A | 0 |
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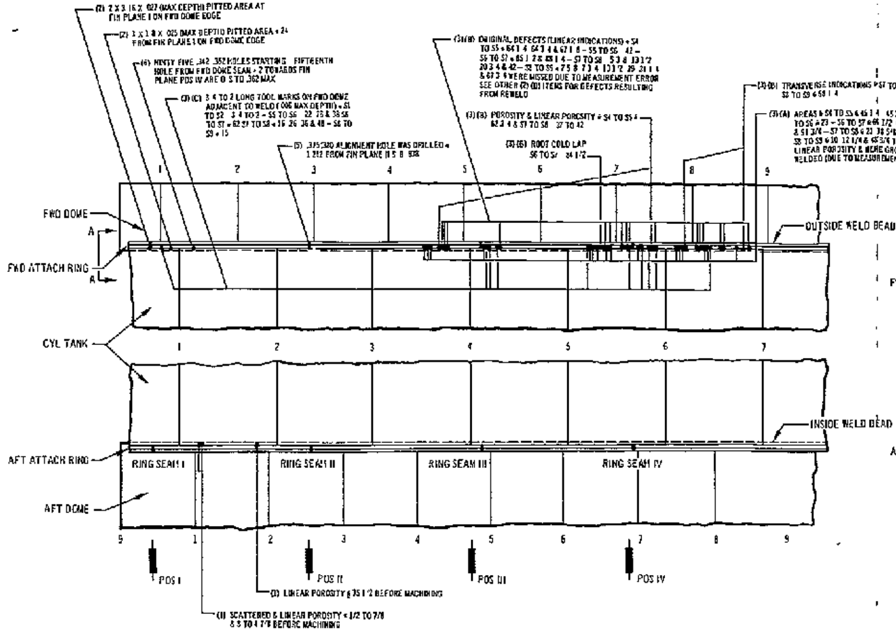
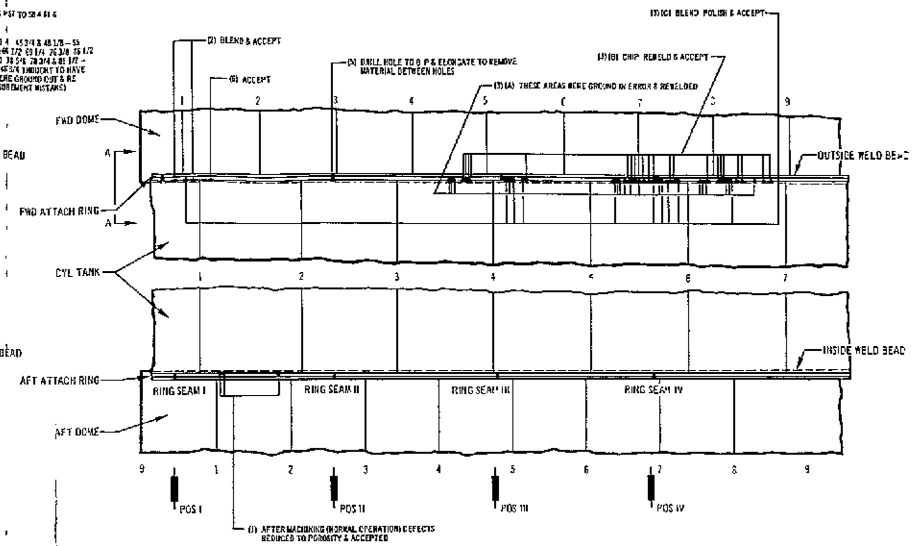
Chart 1. Forward Dome Assembly

FOLDOUT FRAME 1

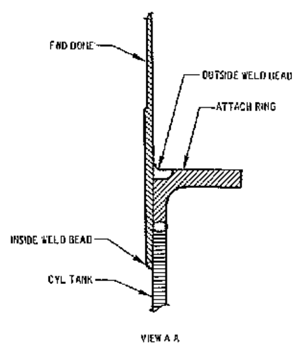
FOLDOUT FRAME 2

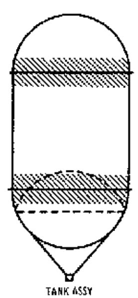



## DEFECTS




## REWORKS




| ITEM | FARR NUMBER | INITIATION DATE | DEFECTS | REWORKS REQUIRED | WELDING REWORK | REWELDS |
|---|---|---|---|---|---|---|
| (1) | A221155 | 10-23-65 | 3 | 0 | N/A | 0 |
| (2) | A220490 | 11-1-65 | 2 | 2 | N/A | 0 |
| (3) | A220491 | 11-3-65 | 47 | 47 | AUTO MIG | 2 |
| (4) | A220493 | 11-8-65 | SEE AFT DOME – ITEM 15 | | | |
| (5) | A220494 | 11-10-65 | 1 | 1 | N/A | 0 |
| (6) | A220496 | 11-10-65 | 55 | 0 | N/A | 0 |
| (7) | A220497 | 11-19-65 | | SEE FWD DOME – ITEM 13 | | |
| (8) | A220452 | 11-19-65 | | SEE COMMON TO AFT DOME – ITEM 2 | | |
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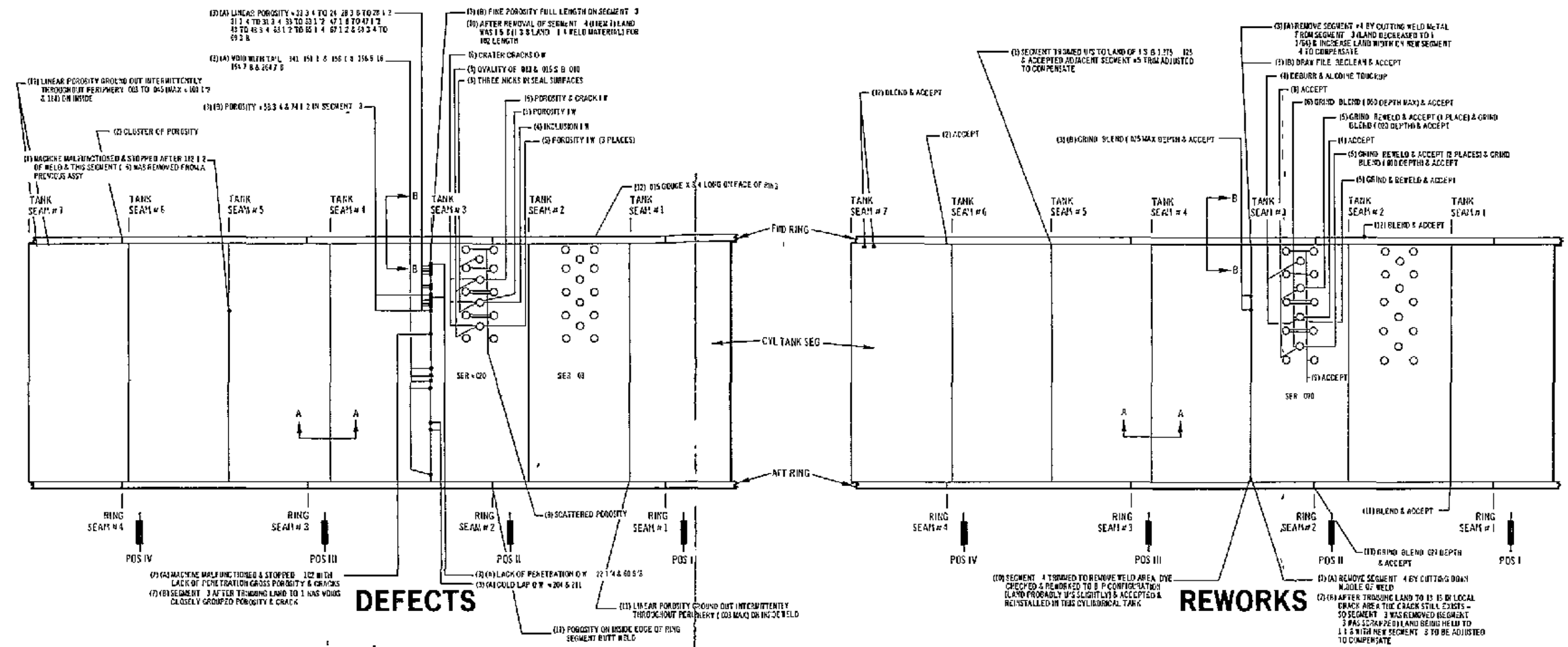
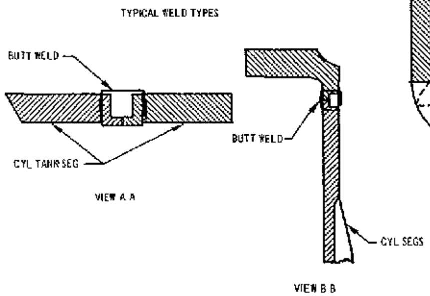
| ITEM | FARR NUMBER | INITIATION DATE | DEFECTS | REWORKS REQUIRED | WELDING REWORK | REWELDS |
|---|---|---|---|---|---|---|
| | | | | | | |

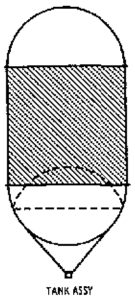
Chart 2. Forward Dome and LOX Tank to Cylinder Welds

FOLDOUT FRAME 1

FOLDOUT FRAME 2



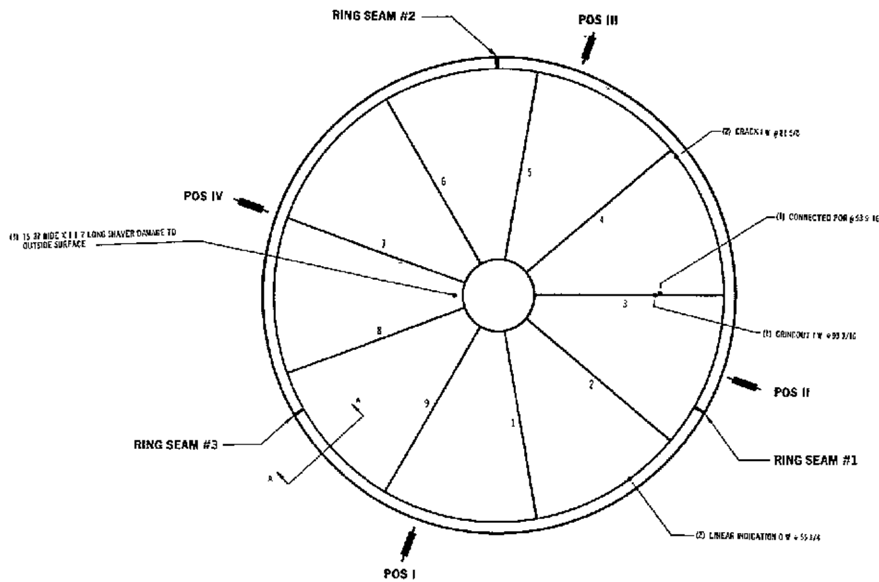

| ITEM | FARR NUMBER | INITIATION DATE | DEFECTS | REWORKS REQUIRED | WELDING REWORK | REWELDS |
|---|---|---|---|---|---|---|
| 1 | A215452 | 10-5-66 | 1 | 1 | AUTO MIG | 1 |
| 2 | A205845 BEFORE MACH | 12-29-66 | 1 | 0 | N/A | 0 |
| 3 | A209523 | 9-13-66 | 11 | 4 | AUTO MIG | 1 |
| 4 | A223413 | 9-14-66 | 1 | 0 | N/A | 0 |
| 5 | A223434 | 9-14-65 | 6 | 6 | AUTO TIG | 4 |
| 6 | A223440 | 9-20-66 | 3 | 3 | N/A | 0 |
| 7 | A220241 | 9-22-66 | 1 | 1 | AUTO MIG | 2 |
| 8 | A220531 | 9-22-66 | 5 | 3 | N/A | 0 |
| 9 | A22[illegible]449 | 9-29-55 | 14 | 3 | N/A | 0 |
| 10 | A220401 | 9-29-56 | 1 | 1 | AUTO MIG | 1 |

| ITEM | FARR NUMBER | INITIATION DATE | DEFECTS | REWORKS REQUIRED | WELDING REWORK | REWELDS |
|---|---|---|---|---|---|---|
| 11 | A220429 | 10-13-66 | 2 | 2 | N/A | 0 |
| 12 | A220431 | 10-13-66 | 3 | 3 | N/A | 0 |

Chart 3. Cylindrical Tank Assembly

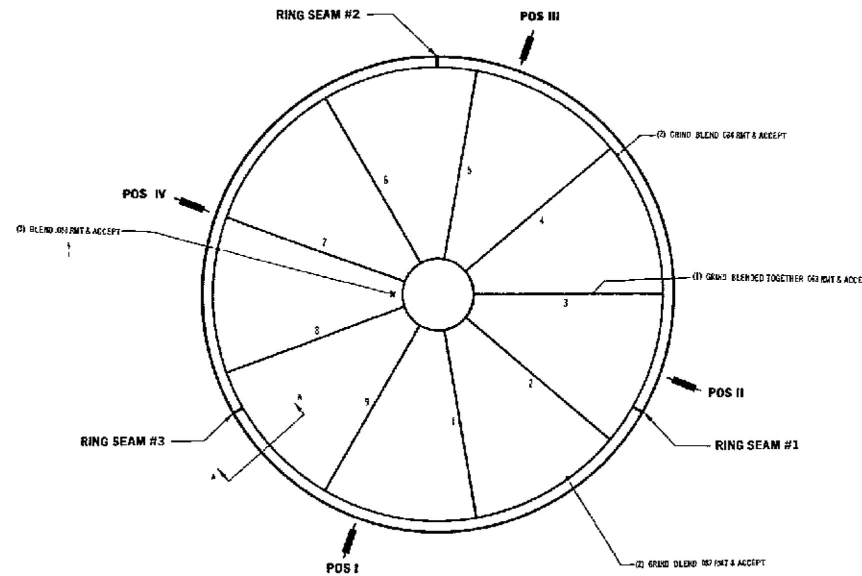
FOLDOUT FRAME 1

FOLDOUT FRAME 2



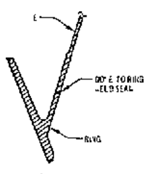

**DEFECTS**

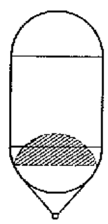
VIEW LOOKING AFT




**REWORKS**

VIEW LOOKING AFT




| ITEM | FARR NUMBER | INITIATION DATE | DEFECTS | REWORKS REQUIRED | HOW REWORKED | REWELDS |
|---|---|---|---|---|---|---|
| (1) | A206821 | 8-6-66 | 2 | 1 | N/A | 0 |
| (2) | A206843 | 8-17-66 | 2 | 2 | N/A | 0 |
| (3) | A206847 | 8-21-66 | 1 | 1 | N/A | 0 |
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| ITEM | FARR NUMBER | INITIATION DATE | DEFECTS | REWORKS REQUIRED | WELDING REWORK | REWELDS |
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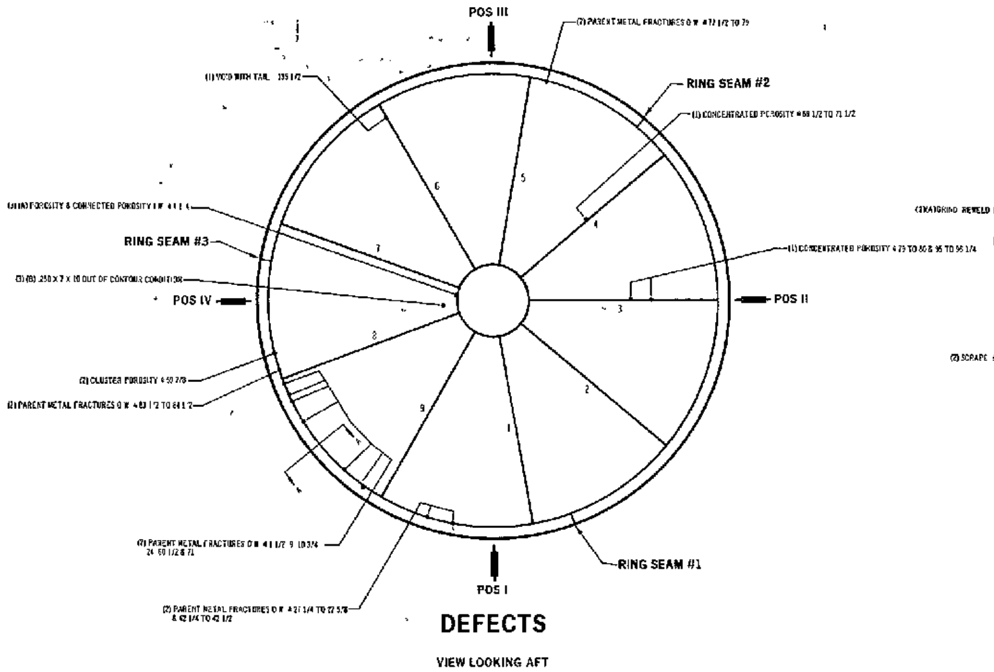
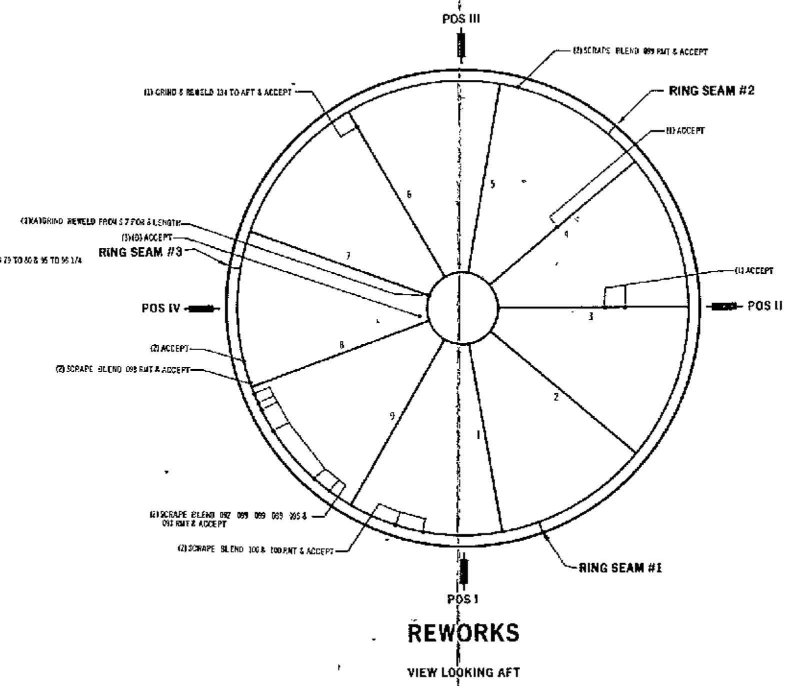
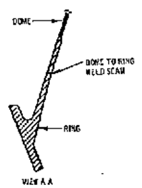
Chart 4. Forward Face Assembly

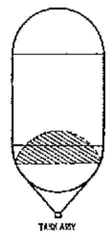
FOLDOUT FRAME 1

FOLDOUT FRAME 2



| ITEM | FARR NUMBER | INITIATION DATE | DEFECTS | REWORKS REQUIRED | HOW REWORKED | REWELDS |
|---|---|---|---|---|---|---|
| (1) | A205864 | 7-22-66 | 4 | 1 | AUTO MIG | 1 |
| (2) | A220509 | 8-29-66 | 11 | 10 | N/A | 0 |
| (3) | A220616 | 9-1-66 | 2 | 1 | AUTO MIG | 1 |
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| ITEM | FARR NUMBER | INITIATION DATE | DEFECTS | REWORKS REQUIRED | WELDING REWORK | REWELDS |
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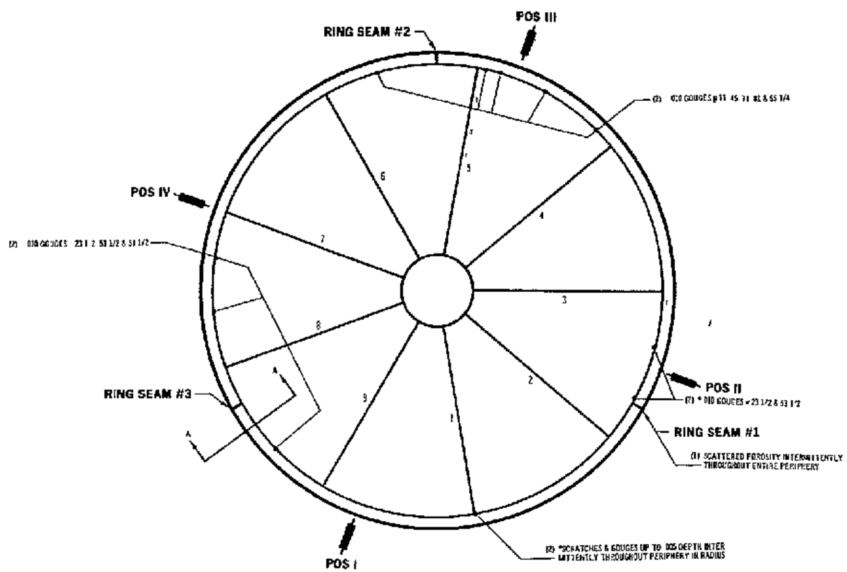
Chart 5. Aft Face Assembly

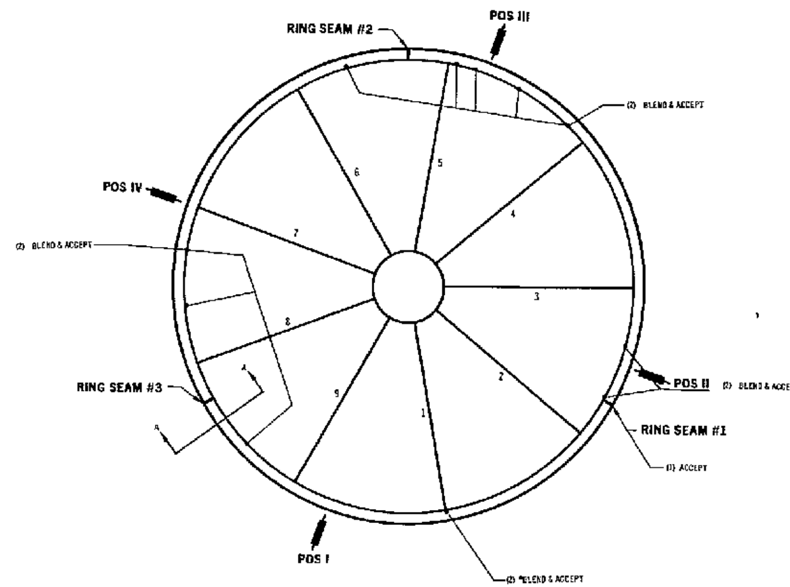
FOLDOUT FRAME

FOLDOUT FRAME 2



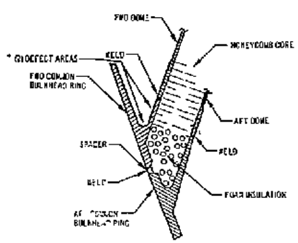

**DEFECTS**

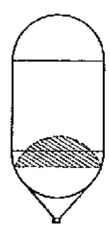
VIEW LOOKING AFT




**REWORKS**

VIEW LOOKING AFT




| ITEM | FARR NUMBER | INITIATION DATE | DEFECTS | REWORKS REQUIRED | HOW REWORKED | REWELDS |
|---|---|---|---|---|---|---|
| (1) | A223484 | 9-30-66 | 1 | 0 | N/A | 0 |
| (2) | A223485 | 10-6-66 | 11 | 11 | N/A | 0 |
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| ITEM | FARR NUMBER | INITIATION DATE | DEFECTS | REWORKS REQUIRED | WELDING REWORK | REWELDS |
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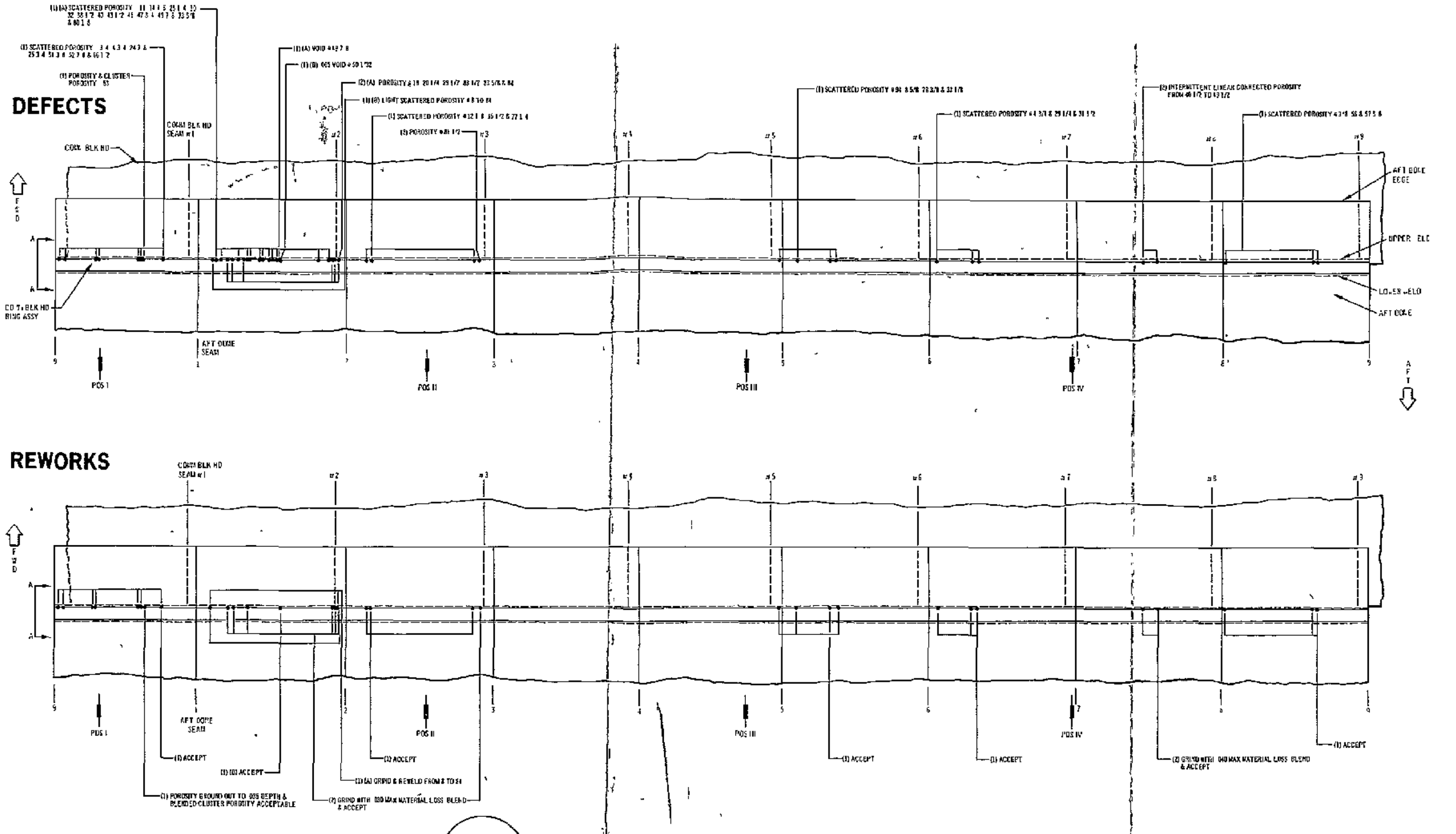
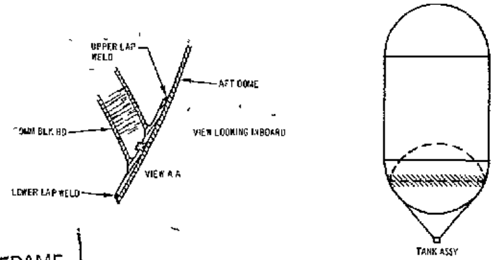
Chart 6. Common Bulkhead Assembly

FOLDOUT FRAME 1

FOLDOUT FRAME 2




LEGEND

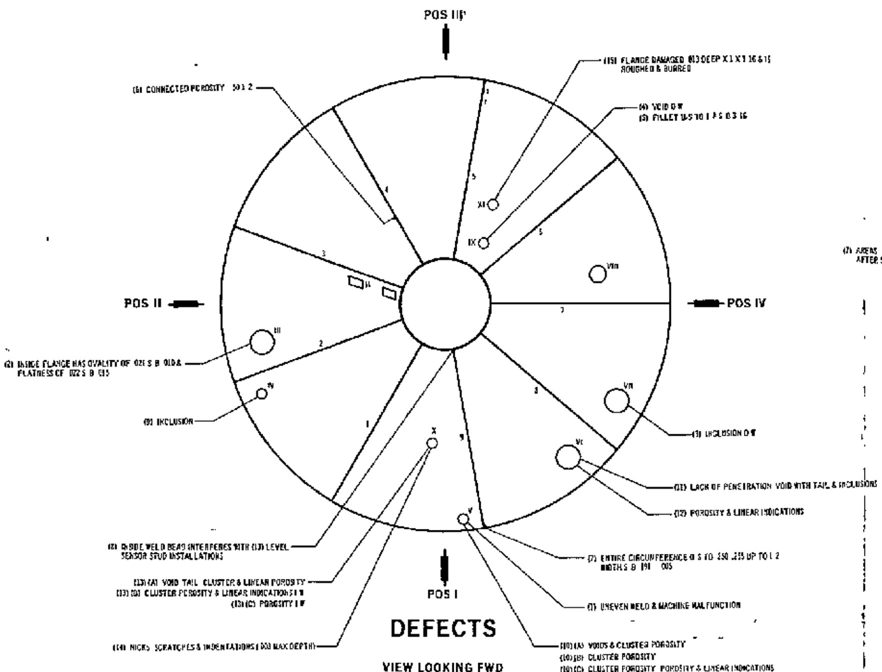
| ITEM | FABR NUMBER | INITIATION DATE | DEFECTS | REWORKS REQUIRED | WELDING REWORK | REWELDS |
|---|---|---|---|---|---|---|
| (1) | A151005 | 10-11-66 | 37 | 2 | AUTO MIG | 1 |
| (2) | A225451 | 10-19-66 | 6 | 6 | N/A | 0 |
| | | | | | | |

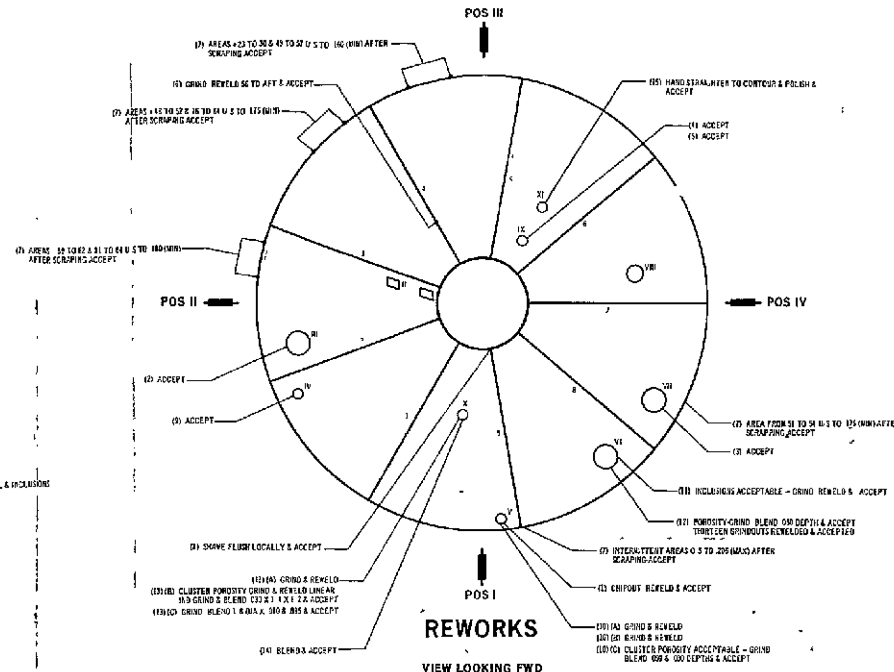
| ITEM | FABR NUMBER | INITIATION DATE | DEFECTS | REWORKS REQUIRED | WELDING REWORK | REWELDS |
|---|---|---|---|---|---|---|
| | | | | | | |

Chart 7 Common Bulkhead to Aft Dome Weld

FOLDOUT FRAME 1

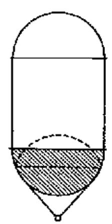
FOLDOUT FRAME 2




LEGEND

- I BRACKET
- II BRACKET
- III [illegible] LOX FILL LINE
- IV ELBOW ASSY LH FILL LINE
- V ELBOW ASSY LH CHILL RETURN
- VI FITTING ASSY LH FEED LINE
- VII FLANGE LH CHILL PUMP
- VIII FLANGE LOX JOINT
- IX WIRE LEADOUT PORT
- X LOX CHILL RETURN
- XI P U PROBE




HAND WELD

| ITEM | FARR NUMBER | | INITIATION DATE | DEFECTS | REWORKS REQUIRED | HOW REWORKED | REWELDS |
|---|---|---|---|---|---|---|---|
| (1) | A206479 | D-D | 5-10-66 | 1 | 1 | AUTO TIG | 1 |
| (2) | A206853 | A A | 8 18-66 | 2 | 0 | N A | 0 |
| (3) | A206545 | F F | 8 19-66 | 1 | 0 | N A | 0 |
| (4) | A220505 | K K | 8-24-66 | 1 | 0 | N A | 0 |
| (5) | A206900 | K K | 8 25 66 | 1 | 0 | N A | 0 |
| (6) | A220524 | MER | 9-8 66 | 1 | 1 | AUTO MIG | 1 |
| (7) | A220677 | | 9 14-66 | 8 | 8 | N A | 0 |
| (8) | A220589 | | 9-21 66 | 13 | 13 | N A | 0 |
| (9) | A223447 | DB | 9 23 66 | 1 | 0 | N A | 0 |
| (10) | A223448 | DD | 9 23 66 | 3 | 4 | MANUAL TIG | 2 |

| ITEM | FARR NUMBER | | INITIATION DATE | DEFECTS | REWORKS REQUIRED | WELDING REWORK | REWELDS |
|---|---|---|---|---|---|---|---|
| (11) | A223405 | E E | 9 23-66 | 4 | 1 | MANUAL TIG | 1 |
| (12) | A223451 | E E | 9-21-66 | 14 | 2 | MANUAL TIG | 1 |
| (13) | A223460 | DD | 9-28-66 | 7 | 5 | MANUAL TIG | 2 |
| (14) | A223482 | EE | 9-20-66 | 1 | 1 | N/A | 0 |
| (15) | A220453 | KK | 11 3 66 | 1 | 1 | N/A | 0 |
| | | | | | | | |
| | | | | | | | |
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| | | | | | | | |

Chart 8. Aft Dome Assembly

FOLDOUT FRAME 1

FOLDOUT FRAME 2

TABLE I. FAILURE AND REJECTION REPORTS OF
PERMANENT NONCONFORMANCES, STRUCTURAL ASSEMBLIES

Section 1. Tank Assembly, P/N 1B39303-529

| FARR NO | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A217149<br>11-23-66 | Support clip, P/N 1B37888-529, overlapped the scrim cloth by only 3/32 in. Minimum allowable overlap was 1/4 in. per DPS 32330. | Acceptable to Engineering for use. |
| A220452<br>11-19-66 | Dye penetrant inspection of the inside common bulkhead to aft dome weld revealed:<br>a. Greater than No. 3 porosity, six locations between seams 1 and 2.<br>b. Intermittent linear porosity between seams 7 and 8.<br>c. Greater than No. 3 porosity one location between seams 2 and 3. | a., b., and c. Porosities were ground out, blended to a 10 to 1 ratio, polished, dye checked, and accepted. |
| A220455<br>11-28-66 | Support clip, P/N 1B54217-1, was installed on unprimed surface at seam 3 on forward dome. | The clip was removed and the area primed per blueprint. |
| A220456<br>11-29-66 | At station 403, of the main tunnel, the supports, P/N's 1B37889-531, 1B37889-521, and 1B37414-1 were installed on an unprimed surface, of the LOX and $LH_2$ tank assembly, P/N 1A39303-525. | The supports were removed and the entire area was primed per Douglas Process Standard (DPS) 32330. The rework was acceptable to Engineering for use. |
| A220458<br>12-5-66 | During the LOX and $LH_2$ tank assembly, P/N 1A39303-521, tiling operation it was noted that tile numbers 200 through 320 for segment 3, of the cylinder tank, had easily discernible yellow streaks of hardener in the adhesive, which was contrary to DPS 23003. | Engineering accepted the tile for use. |

TABLE I, Section 1 (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A220460<br>12-6-66 | Tiles 1 through 65, of LOX and $LH_2$ tank assembly, P/N 1A39303-521, for the center of segment 6, had easily discernible streaks of yellow in the hardener, which was contrary to DPS 23003. | Engineering accepted the tile for use. |
| A220461<br>12-10-66 | During the tile and glass liner operation, of the LOX and $LH_2$ tank assembly, P/N 1A39303-521, cylinder seam 2 had vacuum indications below the 20 in. Hg. for a 7 hour period. DPS 23003 required 20 in. Hg. during the cure cycle. | Engineering pulled some test coupons and accepted the tile on the basis of the test results. |
| A220463<br>12-19-66 | Inspection of the LOX and $LH_2$ tank assembly, P/N 1A39303-529 noted:<br>a. The forward dome glass liner, segments 4 and 7, had areas (6 square in. and 72 square in., respectively) not covered by rubcoat.<br>b. The center segment 1 glass liner had two areas 18 square in. not covered by rubcoat.<br>c. The aft dome segment 9 glass liner had areas 64 square in. not covered by rubcoat.<br>d. The rubcoat applied over the doublers in center segments 3 and 4 had runs. | Defective items a through d were acceptable to Engineering for use. |
| A220489<br>10-19-66 | The preproduction test sample of the LOX and $LH_2$ tank assembly, P/N 1A39303-529, S/N 2011, aft dome to cylinder weld did not comply with DPS 14052, which stated that the test coupon should have the same configuration and cross section as the stage. | The weld was acceptable to Engineering after a post production sample was made. |

TABLE I, Section 1 (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A220490 11-1-66 | Inspection of the LOX and $LH_2$ tank assembly, P/N 1A39303-529, revealed pitted areas in the aft inside edge of forward dome, segment 3. The pitted areas were 2 in. by 3/16 in. by 0.027 in. and 1 in. by 1/8 in. by 0.025 in. | The pitted areas were blended out to remove the defects. The rework was acceptable to Engineering for use. |
| A220491 11-3-66 | X-ray inspection of the forward dome to cylinder inside weld on tank assembly, P/N 1A39303-529, S/N 2011, revealed linear porosities starting from the set-up line at the following seams: 5 toward 6, 6 toward 7, 7 toward 8, and 8 toward 9. | All defects were ground, chipped, rewelded and blended as necessary. The rework was acceptable to Engineering for use. |
| A220493 11-8-66 | On tank assembly, P/N 1A39303-529, S/N 2011, there was a dinged area on the edge of the PU probe flange, P/N 1A39152-501. | The rework by forming and polishing was acceptable to Engineering for use. |
| A220494 11-10-66 | On tank assembly, P/N 1A39303-529, S/N 2011, the 0.375/0.380 diameter alignment hole through the forward attach angle that locates the A652-1A39303-1SF25 drill jig was mislocated 1.252 in. to the right of position No. 2. Per B/P, should be 0.938 in. | The mislocated hole was reworked by drilling the hole per B/P and removing the material between the existing hole and the hole drilled per B/P. The rework was acceptable to Engineering for use. |
| A220496 11-10-66 | On tank assembly, P/N 1A39303-529, S/N 2011, forward attach ring, 95 holes were arranged from 0.355 in. to maximum 0.362, and should have been 0.342 to 0.351 in. diameter per B/P. | Acceptable to Engineering for use. |
| A220497 11-19-66 | A dye check of the cylinder tank assembly, P/N 1A39303-521, revealed:<br>a. The vent line port in segment 3 had a 1/8 in. transverse dye indication. | Defects a. and b. were ground out and blended. The rework was acceptable to Engineering for use. |

TABLE I, Section 1 (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A220497 (Con't) | b. The propellant utilization wire leadout port in segment 7 had a 1/8 in. transverse dye indication and a greater than number 3 porosity. | |
| A228159 10-23-66 | X-ray of outside weld joining aft dome to cylinder of tank assembly, P/N 1A39303, S/N 2011, revealed three areas having scattered and linear porosities. | After machining, X-ray inspection showed porosity remaining in some areas. This condition was accepted by Engineering for use. |
| A233432 12-15-66 | FARR A217130 disposition rework resulted in void areas between debris shroud and tank assembly, P/N 1A39303-533, S/N 2011, at all weld seam locations. | Acceptable to Engineering for use. |
| A233426 11-29-66 | Coupon tests for the following supports did not meet T-peel test requirements per DPS 32330, average of three coupons: Two 1A39318-401, four 1B31140-1, four 1B37414-1, five 1B37889-521, ten 1B37889-531, five 1B37899-1, five 1B37899-501, four 1B37899-501, four 1B39313-401, and one 1B37888-529. Coupon tests indicated an average of 26 in.-lb./in. Should be 27 in.-lb./in. | Final lap shear and T-peel tests were submitted and found to be acceptable to Engineering for use. |
| A233434 12-21-66 | Test coupons show that support assembly, P/N 1B37414-1, support assembly, P/N 1B37889-521, and two support assemblies, P/N 1B37889-531, located at main tunnel, station 403, do not meet installation strength requirements of coupon test per DPS 32330. | Noted supports were removed and replaced per DPS 32330. |

TABLE I, Section 1 (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A233559<br>12-21-66 | Two leak ports in cold helium spheres, P/N 1A48858-1, S/N's 1156 and 1157, were reversed 180 degrees. | Production was instructed to rotate helium spheres 180 degrees to orient parts per next assembly drawing 1A57523. Acceptable for use. |
| A233564<br>12-28-66 | Slots in flange of duct assembly, P/N 1B64967-1, were 1/4 to 3/4 in. misaligned with holes in flange assembly, P/N 1B64442, inside the tank assembly at the forward dome. | The 0.257 to 0.261 in. holes in the flange assembly, P/N 1B64442, were relocated to pick up slotted holes in duct assembly, P/N 1B64967-1. Installation was acceptable for use. |
| A233565<br>1-3-67 | A visual inspection inside tank assembly, P/N 1A39303-529, revealed the following discrepancies:<br><br>a. Anti-vortex screen, P/N 1A48633-501 had indication of corrosion.<br><br>b. Blue colored identification markings on weld seam on forward common bulkhead adjacent to meridian seams 4, 5, and 6. | a. Anti-vortex screen was removed and replaced.<br><br>b. Attempt to remove blue markings with solvent per DPS 43110 was not successful. Acceptable to Engineering for use. |
| A233569<br>1-7-67 | Found corrosion on two stud assemblies, P/N 1B37398-1, inside the LOX tank assembly. | The two stud assemblies were removed and replaced. The rework was acceptable to Engineering for use. |
| A233581<br>1-11-67 | A No. 10 hole was drilled in edge of 0.249 to 0.255 hole in interface angle, P/N 1A66946-1. The No. 10 hole was drilled three fourths through the angle. | The No. 10 hole was drilled through the angle and flushed off with an MS20426DD rivet. The 0.249 to 0.255 hole was reamed out to remove a portion of the plug protruding into it. Installation was completed per blueprint. The rework was acceptable to Engineering for use. |

TABLE I, Section 1 (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A233585 1-14-67 | Stringer 22 on aft skirt panel, P/N 1B34439-1, is mislocated 1/4 in. and unable to secure pipe assembly, P/N 1B52556-1 to stringer. | Two TA11C35D10T clamps were replaced with TA778SS10T clamps and installed forward of original location. Line was secured and rework was accepted. |
| A233588 1-18-67 | Inspection revealed that the LOX chilldown return elbow assembly was installed in a canted position resulting in the inability to install the resilient mount, P/N 1A49962 -511, in an unrestrained position on the duct assembly, P/N 1A87736-1. | The resilient mount was trimmed as necessary to permit unrestrained installation and maintain a 1/32 in. minimum clearance for the duct with the mount compressed. The rework was acceptable to Engineering for use. |
| A233590 1-23-67 | Inspection of the stage, P/N 1A74633-517, revealed that the cloth boots on the seal assembly, P/N 1B44620-1, were cut two places on the upper boot and one place on the lower boot. | The defective boots were repaired by patching, using the same type of material as the boot. Bostic cement was used as the adhesive. Engineering accepted the rework for use. |
| A233594 1-26-67 | Inspection of stage, P/N 1A74633-517, revealed that the LOX chilldown duct, P/N 1A87736-1, rode against the bracket that held the resilient mount, P/N 1A49962-515. The duct could not be moved because the angular requirement per the blueprint could not be held. | A portion of the flange on the bracket, P/N 1B34894-38, nearest stringer 2 was removed to provide clearance for the duct. The rework was acceptable to Engineering for use. |
| A243516 1-25-67 | Inspection of the stage, P/N 1A74633-517, revealed that the insulation on the wire harness, P/N 1B58093-1, S/N 0341, melted when the shrink tubing was shrunk. | The wire harness was acceptable to Engineering for use without rework. |

TABLE I, (Continued)

Section 2. Forward Dome, P/N 1B64442-501

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
| --- | --- | --- |
| A150976 10-24-66 | Pi-tape diameter at the equatorial plane, zone 8, of the forward dome meridian, P/N 1B64442-403, S/N 2011, is 259.655 in.; it should be 259.736 $\pm$ 0.060 in. | Acceptable to Engineering for use. |
| A150987 10-29-66 | Ovality of the forward dome flange installation, section "AA", zone 10, P/N 1B64442-401, S/N 2011, is 0.035 in.; it should be 0.00 in. per B/P. | Acceptable to Engineering for use. |
| A151020 10-18-66 | X-ray 66-B123 of segment 4, $LH_2$ pressure port flange of the forward dome fitting installation, P/N 1B64442-415, S/N 028, showed a disturbed setup line, view 1 of the outside weld. | Acceptable to Engineering for use. |
| A151043 10-29-66 | X-ray inspection of the forward dome flange installation, P/N 1B64442-401, S/N 2011, revealed a No. 3 porosity, linear indication, and two linear porosities. | After all noted defects were scraped, ground, etched for 3 min., and dye checked, the weld quality was acceptable and the rework was acceptable to Engineering for use. |
| A220523 9-7-66 | X-ray 66-B107 of the inside weld of the forward dome fitting installation, P/N 1B64442-417, S/N 022, showed three less dense inclusions. | Acceptable to Engineering for use. |
| A220566 9-6-66 | Inspection showed 0.080 by 3/32 in. diameter blow holes at the edge of the weld adjacent to the forward side of fitting "CC" installation, P/N 1B64442-413, S/N 020. | The defect was ground out and mechanically rewelded. X-ray and dye check showed the weld quality acceptable, and the reweld acceptable to Engineering for use. |

TABLE I, Section 2 (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A220573 9-12-66 | Inspection at the intersection of the inside fillet weld and the inside flange of "FF" fitting installation of the forward dome, P/N 1B64442-413, S/N 2011, showed a 0.060 in. grind out and a rough area. | The grindout was smoothed and blended, and the rough area smoothed up. Both areas were etched and dye checked and depths measured. No defects were revealed by the dye check, and the blendouts were acceptable to Engineering for use. |
| A223441 9-20-66 | X-ray 66-B107 of fitting "DD" outside weld showed less dense inclusions, and a dye check of fitting "DD", outside weld showed a crater crack at view 4. | The less dense inclusions were acceptable; however, the crater crack area required scrapping and etching before acceptance by Engineering. |
| A223444 9-21-66 | X-ray 66-B107 of segment 8, clip "HH", to segment weld, showed a crack. After grindout, X66-B107, R1 showed no defects, but the defect was ground to the setup line. | The area was cleaned per DPS 41006 and mechanically rewelded. X-ray and dye check showed the weld quality acceptable to Engineering for use. |
| A223462 9-28-66 | X-ray inspection showed seam 1 of the pre-production meridian welds of the forward dome, P/N 1B64442-403, S/N 2011, had a void with a tail. | Acceptable to Engineering for use. |
| A223467 10-1-66 | X-ray 66-B107 showed a cold lap at the root of the inside weld, view 4, of the forward dome segment. | Acceptable to Engineering for use. |
| A223480 9-28-66 | Forward dome, P/N 1B64442-415, S/N 2011, sensor fitting installation "DD" of the $LH_2$ pressurization inside weld, view 4, had a lack of fill. | The area was ground in preparation for rewelding, and mechanically rewelded. The voids, following the reweld, were acceptable to Engineering for use. The other defective areas were ground out to a 10 to 1 ratio, smoothed and blended. After dye check and blend, the rework was acceptable to Engineering for use. |

TABLE I, Section 2 (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A223484 10-3-66 | X-ray, dye check, and visual inspection of forward dome, P/N 1B64442-403, S/N 2011, showed No. 3 porosity, linear porosity, voids with tails, connected porosity, less dense inclusions, suck-back, and cold laps at numerous places in meridian seams 1, 2, 3, 4, 5, 7, and 8. | Welds were ground out, smoothed, etched and blended to remove most of the defects. The remaining defects were removed by milling and rewelding defective portions of the welds. All reworks were acceptable to Engineering for use. |

TABLE I (Continued)

Section 3. Cylindrical Tank Assembly, P/N 1A39306-509

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A195529<br>6-1-66 | Seventeen pasajell splatters on waffle pattern and ribs of cylinder tank segment, P/N 1A39277-503, S/N 00124. | Accepted by Engineering for use after defects were blended out. |
| A206846<br>8-20-66 | X-ray 66-B99 of seam 4 in the forward ring assembly, P/N 1A39306-35.1, S/N 013, showed clusters of porosity. | Acceptable to Engineering for use. |
| A206849<br>8-21-66 | Dye check of welds on aft ring assembly, P/N 1A39306-33.1, S/N 013, showed the following defects:<br>a. Clusters of porosity and linear porosity in seam 4.<br>b. Crack in seam 2. | a. Defective area was rewelded, smoothed, and blended to an acceptable condition.<br>b. Defects were ground out, etched, smoothed, and blended to an acceptable condition. |
| A209523<br>9-13-66 | Visual inspection and X-ray 66-59 of long seam 3 on cylinder tank assembly, P/N 1A39306-509, S/N 2011, disclosed a lack of weld penetration at two places, two cold laps, linear porosity, and voids with tails several places. | Segment 4 was removed and all weld materials and defects were removed from edge of segment 3. New segment 4 was prepared and trimmed to maintain original dimensions across weld land area. Acceptable to Engineering for use. |
| A215814<br>8-1-66 | Open pilot hole (No. 40) in -35 frame. The hole is 1/4 in. center to center from the MS20470AD-5 rivet. | Acceptable to Engineering for use. |
| A216982<br>10-13-66 | Transverse crack in weld located 112 in. from forward end on seam 5 side of the cylinder tank segment 6, P/N 1A39306-31, S/N 026. This condition existed when removed from the stage 1009. | Weld deposit and crack defects were removed by trimming from seam 5 on the side of segment 6. The rework was acceptable for use. |

TABLE I, Section 3 (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A220241<br>9-22-66 | During welding of long seam 3 on cylinder tank assembly, P/N 1A39306-509, S/N 2011, the welding machine stopped after welding 102 in. of the 189 in. seam. X-ray 66-59 revealed irregularity, concentrated porosity, two cracks, and a lack of fusion in the last 5 in. of the weld. | Segments 3 and 4 were removed. Segment 3 was replaced by a new segment. Segment 4 was salvaged by FARR A220401 and reinstalled. Welds for seams 2 and 3 were accepted on FARR A220401. |
| A220401<br>9-29-66 | Cylinder tank segment 4, P/N 1A39306-27, S/N 037, removed from stage by FARR A220241 had an excessive weld deposit at seam 3 from forward end to 102 in. toward aft end. | Segment was trimmed at seam 3 to remove weld deposit and rechamfered to blueprint tolerances. Reinstallation of segment 4 and weld seams 3 and 4 were accepted by Engineering for use. |
| A220431<br>10-13-66 | An intermittent depth of 0.003 to 0.045 in. below parent metal existed as a result of grinding to remove linear porosity in the weld at the forward ring to the cylinder tank assembly, P/N 1A39306-509. | Defective area was smoothed and blended to a 10 to 1 ration and was acceptable to Engineering for use. |
| A220429<br>10-15-66 | Dye check showed a greater than No. 3 porosity in the butt weld 2 on the inboard edge of the aft ring to the cylinder tank assembly, P/N 1A39306-509. | The defects were ground out and smoothed to an acceptable condition. |
| A220250<br>9-29-66 | The cylinder tank segment 4, P/N 1A39306-27, S/N 034, removed per FARR A209523 had a land area of 1 1/8 in. plus 1/4 in. of weld deposit remaining. | The seam 3 edge of segment 4 was rechamfered and blended with a remaining land area of 1 1/8 in. The rework was acceptable to Engineering, however, a new segment 4, S/N 037, trimmed to a wider dimension was installed on stage 210 and segment 4, S/N 034, was returned to stock. |

TABLE I, Section 3 (Continued)

| FARR NO | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A220507<br>8-26-66 | Dye check of welds on forward ring assembly, P/N 1A39306-35.1, S/N 013, showed No. 3 porosity and linear porosity in seam 2 and No. 3 porosity in seam 4. | Defects were ground out, scraped, etched, and blended to an acceptable condition. |
| A220591<br>9-22-66 | Helium bottle support fittings, P/N 1A39306-405, S/N 020, have the following discrepancies:<br>a. Ovality of fitting 2 is 0.013 and ovality of fitting 4 is 0 016 Blueprint tolerance is 0 010.<br>b Small nicks were present in sealing surface of fittings 1 and 3 | a. Acceptable to Engineering for use.<br>b. Nicks were deburred and touched up with alodine per DPS 41410 and accepted by Engineering for use. |
| A223433<br>9-14-66 | X-ray 66-B110, IW, 3V2 of the helium bottle support fitting, P/N 1A39306-405, S/N 020, weld showed less dense inclusion | Acceptable to Engineering for use. |
| A223434<br>9-14-66 | Dye check of the welds of the helium bottle support fitting, P/N 1A39306-405, S/N 020, showed one crack and several areas of No. 3 porosity at the fittings 2, 3, and 4. | The welds were ground and scraped to remove cracks and porosity. All weld areas where grind outs exceeded tolerances were rewelded Dye check and X-ray showed no rejectable defects. The rework was acceptable to Engineering for use. |
| A223440<br>9-20-66 | Dye check of the outside weld on helium bottle support fitting, P/N 1A39306-405, S/N 020, to the cylinder segment showed crater cracks in the welds at fittings 2, 3, and 4. | The welds were ground out, scraped, and etched to eliminate the defects. The rework was acceptable with the maximum grind out depths of 0.030 at fitting 2, 0.050 at fitting 3, and and 0.030 at fitting 4. |

TABLE I, Section 3 (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A223449<br>9-23-66 | X-ray 66-B110 of the cylinder tank clevis welds, P/N 1A39306-405, S/N 020, showed scattered porosity in weld clevis 1, 2, 3, 4, 5, 6, 7, and 8. | Acceptable to Engineering for use. |

TABLE I (Continued)

Section 4. Liquid Oxygen Tank Assembly, P/N 1A39307-517

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A151005<br>10-11-66 | Dye check of the circumferential weld at LOX tank common bulkhead installation, P/N 1A39307-459, S/N 2011, revealed the following:<br>a. Scattered porosity throughout the weld.<br>b. Cluster porosity between seam 9 and seam 1.<br>c. A 0.065 in. void between seam 1 and seam 2. | a. and b. Defective areas were ground out, smoothed, and blended to an acceptable condition.<br>c. Approximately 1/2 of fillet weld was ground out and rewelded. Quality of reweld was acceptable. |

TABLE I (Continued)

Section 5. Common Bulkhead Assembly, P/N 1A39309-501

| FARR NO | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A154047 10-3-66 | Common bulkhead assembly, P/N 1A39309-501, S/N 2011, spherical radius is oversize to 129.716 in It should be 129.660 ± 0.030 in. One fourth ± 1/16 in dimension varies from 0.302 to 0.368 in | Acceptable to Engineering for use. |
| A195570 5-26-66 | The dye check inspection of the hoist fittings, P/N 1A39280-405, S/N 020, revealed a crack and a No. 3 porosity in fittings 2, 4, and 5. | The defects were removed by grinding, etching, and smoothing to an acceptable condition |
| A206781 6-29-66 | X-ray, dye check, and visual inspection of the meridian welds on the aft common bulkhead, P/N 1A39286-403, S/N 2011, revealed the following·<br>a. Seam 6, 0.010 to 0 030 had a mismatch after shave.<br>b Seam 2 had a connected porosity<br>c Seam 3 had connected porosity and a No. 3 porosity<br>d. Seam 5 had mechanical damage | a. Acceptable to Engineering for use.<br>b , c., and d. The defects were ground out and blended to an acceptable condition |
| A206784 7-1-66 | The forward common bulkhead, P/N 1A39280-403, had several creases in the thin section of segment 9 and near seam 9. The maximum depth of creases is 0.050 with no loss of material | The creases were dye checked and the bare spots touched up with alodine There were no further defects found. Acceptable to Engineering for use |
| A206791 7-6-66 | On the inside surface of segment 9 of the forward common bulkhead, P/N 1A39280-403, there were several spots of black residue and discoloration | The area was sanded lightly to remove the defects. The segment was acceptable for use. |

TABLE I, Section 5 (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
| --- | --- | --- |
| A206804<br>7-22-66 | X-ray and dye checks of the meridian welds on the aft common bulkhead, P/N 1A39286, revealed the following:<br><br>a. There was concentrated porosity in seams 3 and 4.<br><br>b. There was a void with tails in seam 6. | a. Acceptable to Engineering for use.<br><br>b. The weld bead was shaved flush on both sides of the defective area and rewelded. The rework was acceptable to Engineering for use. |
| A206821<br>8-7-66 | X-ray and dye checks of the meridian welds at the forward common bulkhead, P/N 1A39280-403, showed connected porosity in seam 3. | The defects were ground out and blended to an acceptable condition. |
| A206843<br>8-17-66 | The dye check of the weld at the dome to the common bulkhead ring installation, P/N 1A39280-401, showed a crack in the parent metal at 81 5/8 in. from seam 3 to seam 4 and a linear indication at 55 1/4 in. from seam 1 to seam 2. | All the defects were ground out and blended to an acceptable condition. |
| A206847<br>8-21-66 | On the surface of the center plate, P/N 1A39280-501, S/N 1007A, there was mechanical damage 1 1/2 in. long, 15/32 in. wide, and maximum depth of 0.015. | The defect was smoothed, blended, and etched to an acceptable condition. |
| A206861<br>7-21-66 | There were pasajell splatters on the common bulkhead forward face near weld seams 2, 3, and 5. | The unit was acceptable after the pasajell splatters were touched up with alodine per DPS 41410. |
| A206875<br>8-3-66 | The outside weld on the ring to the face weld on the forward common bulkhead, P/N 1A39280-401, had a grind out between seams 7 and 8 that was not blended. The grind out depth was 0.012 in. The resubmit after the dye check showed a No. 1 porosity in the defective area. | The defects were ground, etched, and blended to an acceptable condition. |

TABLE I, Section 5 (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A206880 8-11-66 | The forward common bulkhead, P/N 1A39280-403, S/N 1007A, had several pasajell splatters on the outside anodized surface near the weld seams. | Acceptable to Engineering for use. |
| A206885 8-14-66 | There were scattered pits on the inner side of the ring to the face weld on the ring installation, aft common bulkhead, P/N 1A39286-401, S/N 2011. Maximum depth is 0.010 and maximum size is 1/32 in. diameter. | Acceptable to Engineering for use. |
| A220509 8-27-66 | X-ray and dye check of the aft common bulkhead, P/N 1A39286-401, to ring weld revealed parent metal fractures and cluster porosity at seam 4 to 5, seam 7 to 8, seam 8 to 9 and seam 9 to 1. | The defects were removed by scraping, etching, and smoothing to an acceptable condition. |
| A220516 9-1-66 | X-ray and dye check of the aft face center plate, P/N 1A39286-501, revealed number 3 porosity in seams 1 to 9 to 1 inclusive. Reweld of seam 7 to 8 caused a can in the center plate. | The defective weld seams were acceptable to Engineering for use, after grinding and blending out, except for seam 7 to 8, which required one reweld. The resulting can in the center plate was acceptable to Engineering without rework. |
| A222630 9-16-66 | During bonding of the core to the aft face of the common bulkhead, P/N 1A39309-401, thermocouples No. 1, 23, 24, and 25 failed one minute after completion of the 45 minute cure cycle at $330^{\circ}F \pm 5^{\circ}F$. The minimum operating thermocouple allowed is eleven. After cure and during cool down only ten thermocouples were operating. | Test coupons showed that bonding of the core was within strength requirements. Acceptable to Engineering for use. |

TABLE I, Section 5 (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A222633<br>9-23-66 | The honeycomb core attached to the common bulkhead, P/N 1A39309-401, S/N 2011, had numerous knife cuts at the majority of the adhesive laps. The cuts varied from 1/8 to 1/4 in. deep and from 1 to 3 feet in length. | Acceptable to Engineering for use. |
| A222637<br>9-29-66 | During the adhesive cure and bonding of the forward face to the aft face of the common bulkhead, P/N 1A39303-401, S/N 2011, thermocouples Nos. 1, 8, 9, 13, 24, and 25 failed during various stages of the heatup cycle leaving 13 thermocouples operating on the aft face and 16 on the forward face. The temperature spread between lowest and highest temperature readings was 6°F to 7°F between heatup temperatures of 242°F to 322°F. Maximum spread should be 5°F per DPS 31150-1. | The test coupons showed that bonding of the core was within strength requirements. Acceptable to Engineering for use. |
| A223464<br>9-30-66 | The dye check of the common bulkhead seal weld, P/N 1A39309-501, S/N 2011, before machining showed scattered porosity in excess of 3/32 in. intermittently for entire circumference of weld. | Acceptable to Engineering for use. |
| A223489<br>10-6-66 | Defects in the common bulkhead, P/N 1A39309-501, S/N 2011, were as follows:<br>a. Several gouges with maximum depth of 0.010 in. in standing leg of forward ring 5/8 to 3/4 in. aft of ring to face weld.<br>b. Several scratches and gouges with maximum depth of 0.005 in. in radius between base leg and standing leg of forward ring and inside surface of the base leg of the forward ring. | All the scratches and gouges were smoothed and blended to an acceptable condition. |

TABLE I (Continued)

Section 6. Aft Dome Assembly, P/N 1B63286-501

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A206845<br>8-19-66 | X-ray 66-B69 of the outside FF fitting to segment 8 weld showed less dense inclusion in view 4. | Acceptable to Engineering for use. |
| A206879<br>8-10-66 | It was suspected that the inside DD fitting to segment 1 weld was uneven | X-ray 66-B96 revealed that the weld was acceptable for use. |
| A206893<br>8-18-66 | On segment 3, the ovality of the LOX fueling fitting was 0.021 in. Maximum allowable ovality was 0.010 in. The flatness of the same flange was 0 022 in. Maximum allowable was 0.015 in. per B/P 1B63286. | Acceptable to Engineering for use. |
| A206900<br>8-26-66 | The inside fillet weld of the K-K flange to segment 6 was undersize in intermittent areas. | Acceptable to Engineering for use. |
| A220488<br>10-18-66 | The preproduction coupon for the aft dome to cylinder weld did not meet the requirements of DPS 14052. The dome material did not have the same cross section and thickness | Acceptable to Engineering for use. |
| A220505<br>8-24-66 | X-ray 66-B96 of the outside K-K flange to segment 6 weld showed a void at the root in view 3. | Acceptable to Engineering for use. |
| A220524<br>9-8-66 | X-ray, dye check, and visual inspection of meridian seam 4 revealed connected porosity at 50 1/2 in. | The area of porosity was shaved, cleaned, rewelded mechanically, re-X-rayed, re-dye checked, and accepted. |
| A220577<br>9-14-66 | Excess material was found throughout the circumferential trim | The excess material was shaved to an acceptable thickness and radius per Engineering instructions. |

TABLE I, Section 6 (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A220589<br>9-21-66 | The bead on the inner side of the flange weld would not allow the percussion welder head to seat properly for the installation of thirteen level sensor studs. | The bead was shaved flush as necessary to permit the percussion welding of the studs. The shaved areas were dye checked and accepted. |
| A223447<br>9-23-66 | X-ray 66-B96 of the B-B elbow to fitting weld revealed less dense inclusion in view 2. | Acceptable to Engineering for use |
| A223448<br>9-23-66 | X-ray 66-B96 of the D-D elbow to fitting weld showed<br>a. Void and a cluster of porosity in view 1.<br>b. Void in view 2. | Defects were ground out, manually re-welded, blended, etched, dye checked, and accepted. |
| A223450<br>9-23-66 | X-ray 66-B96 of the E-E elbow to fitting weld revealed<br>a. Intermittent lack of penetration and a void with a tail in view 1.<br>b. More dense inclusions in views 3 and 6. | a. Defects were ground out, manually rewelded, re-X-rayed, and accepted.<br>b. Acceptable to Engineering for use. |
| A223453<br>9-24-66 | Dye check of the E-E fitting to elbow weld No. 4 showed<br>a. No 3 porosity between views B and C.<br>b. Linear indications and No. 3 porosity between views C and D. | a. Defect was ground out, blended to a 10 to 1 ratio, etched, dye checked, and accepted.<br>b. Defects were ground out, cleaned, manually rewelded, X-rayed, dye checked, and accepted |

TABLE I, Section 6 (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A223460<br>9-28-66 | X-ray 66-B96 of the C-C elbow to fitting weld showed a void with a tail, a cluster of porosity, and linear porosity in view 1. | Defect areas were ground out, and, manually rewelded The void was dye checked acceptably; however, the porosities were rewelded once more, re-dye checked, and re-X-rayed before being accepted for use. |
| A223482<br>9-30-66 | Intermittent nicks, scratches, and indentations were noted in the outside E-E elbow to fitting, P/N 1A39150-1, weld. | Defects were blended, etched, dye checked, and accepted. |
| A223488<br>10-5-66 | Dome contour and fitting checks revealed<br>a. Four out of contour conditions at 82° latitude.<br>b The "B" dimension on the LOX chilldown return C-C fitting was 0.200 in. Should have been 0.051 in. maximum. | a and b. Acceptable to Engineering for use. |

TABLE I (Continued)

Section 7. Forward Skirt Assembly, P/N 1B29835-505

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A217138<br>11-3-66 | During support bonding, sealant DPM 2531, mix No. 66164, after 48 hours, did not meet the shore hardness requirements of DPS 25082, Table II. After 72 hours, the hardness requirements were achieved. | Acceptable to Engineering for use. |
| A220407<br>10-4-66 | a At stringers 8, 9, 16, 22, 30, 31, 38, 40, 58, 60, and 63, at the aft interface, dimples for 3/16 in. lockbolts in skin, P/N 1B29835-125, were cracked 3/32 in.<br><br>b. At stringer 44, 14 3/4 in. forward of the aft interface, one extra 1/8 in. dimpled hole was drilled 9/16 in. from a 5/32 in. rivet hole in skin, P/N 1B29835-125. | a. The cracks were radiused out and dye checked.<br><br>b. Rivet, P/N MS20426-B5, was installed in the excess hole, flush on the outboard side.<br><br>Both reworks were acceptable |
| A220417<br>10-10-66 | a. At stringers 79 and 24, 48 in. aft of the forward face, five BJ5 rivet holes were drilled, instead of six, in doubler, P/N 1B29835-659.<br><br>b. One of the above BJ5 rivet holes had short edge distance of 1/4 in. Minimum allowable edge distance was 3/8 in<br><br>c. Seven No. 21 holes through doubler, P/N 1B29835-5, were drilled in the stayout area, interfering with the installation of rain shield, P/N 1B29121. | a and b. Acceptable to Engineering for use.<br><br>c. The excess holes were plugged double flush with AD5 rivet material. The rework was acceptable.<br><br>d and e. Angle, P/N 1B29835-73, through which the discrepant holes were drilled, was removed and relocated to provide maximum possible edge distance The rework was acceptable. |

TABLE I, Section 7 (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A220417 (Continued) | d. At stringer 52, 29 in. aft of the forward face plate, one DT6 huckbolt hole had short edge distance of 3/16 in. Minimum allowable edge distance was 3/8 in. | |
| | e. At stringer 46, 29 in. aft of the forward face plate, one DT6 huckbolt hole each had short edge distance of 3/16 in. Minimum allowable edge distance was 3/8 in | |
| | f. At stringer 49, 29 in. aft of the forward face plate, one DT6 huckbolt hole had short edge distance of 1/4 in. Minimum allowable edge distance was 3/8 in. | f. Acceptable to Engineering. |
| A220439 10-18-66 | At stringer 61, at the forward interface, two extra 1/8 in. countersunk holes were drilled through the interface. One hole interfered with an existing No. 40 pilot hole. | The excess holes were plugged double flush with AD4 rivet material, and the No. 40 hole was plugged with AD3 material, and was relocated. The rework was acceptable. |
| A220442 10-20-66 | At stringer 15, 2 9/16 in. forward of the aft interface, three 1/8 in. holes through skin, P/N 1B29835-125, and stringer, were mislocated 1/8 in. aft. This caused a short edge distance of 1/8 in. for a 3/16 in. hi-lok hole in clip, P/N 1B27678-501. | The clip was relocated 1/8 in. aft The rework was acceptable |

TABLE I, Section 7 (Continued)

| FARR NO | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A228352 11-11-66 | Connector J2 on wire harness 404W31, P/N 1A69558-1, S/N 0014, was P/N S0287E-22-55P-026. It should have been P/N PT07CE-22-55P. | The connector was removed and replaced with the B/P part. The rework was acceptable |
| A228356 11-16-66 | Due to misalignment of port of duct, P/N 1A87436 -502, and intercostal, P/N 1B29835-265, the port was inaccessible for leak check. | The intercostal was radiused to permit access to the port. The leak check was performed acceptably |

TABLE I (Continued)

Section 8. Aft Skirt Assembly, P/N 1B29825-507

| FARR NO. | DESCRIPTION | DISPOSITION |
|---|---|---|
| A217172 10-18-66 | Between stringers 61 and 65, at station 220 intercostals were mislocated 1/4 in. clockwise from B/P 1B58905 location. This resulted in a misfit with tool, P/N 1A49625-1-1F1-1 | The tool was placed, using the existing intercostal location, with a 3/16 in. spacer, so that B/P holes could be drilled. The rework was acceptable. |
| A217174 10-21-66 | Between stringers 80 and 81, the holes drilled in supports, P/N's 1B32637-5 and -7, would not align with elbow, P/N 1A77116-1. | B/P attachment holes were drilled in the supports, equidistant between the existing holes, which were left open. Four attachments were used instead of six The rework was acceptable. |
| A217175 11-3-66 | There were two gouges, measuring 0.020 in. and 0.050 in. in length, on thermoconditioning cold plate, P/N 1A98146-511, S/N 00304. | The burrs were removed, and the defective areas were burnished. The rework was acceptable. |
| A220420 10-10-66 | Between stringers 111 and 112, at station 256, an excess 1/4 in. hole was drilled through the aft skin, P/N 1B29825-257, and the under edge of channel, P/N 1A97480-71. | The hole was deburred, and a doubler was fabricated per Engineering instructions and installed using two existing B/P attachments. The rework was acceptable. |

TABLE I (Continued)

Section 9 Thrust Structure, P/N 1A39312-511

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|

No FARR's were recorded against the thrust structure.

TABLE II. PERMANENT NONCONFORMANCES AND FUNCTIONAL FAILURE AND REJECTION REPORTS DURING STAGE SYSTEM CHECKOUTS

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
| --- | --- | --- |
| A150987<br>10-29-66 | Inspection of P/N 1B64442-401, revealed that the flange installed at section AA was out-of-round by 0.035 in. | Out-of-roundness at flange installation acceptable to Engineering for use. |
| A159324<br>2-17-67 | The helium storage sphere, P/N 1A48858-1, S/N 1157, manufactured by Menasco Manufacturing Company, failed the supplier test specification MM3718-F, which allows a maximum deformation of 0.018 in. after proof test to 3500 + 50, - 0 psi. Deformation was 0.020 in. | The defective helium sphere, P/N 1A48858-1, S/N 1157, was removed from stage 2010. Helium sphere, S/N 1143, was installed in stage 2010 to replace S/N 1157. The rework was acceptable to Engineering. |
| A188545<br>2-3-67 | On panel A99, in the forward skirt, connector P23 of wire harness 411A99A10W1, P/N 1B54269-1, had pin R recessed and the rubber grommet had a hole adjacent to pin R. Pin R in the mating connector, P/N 1B57771-561, was bent. | The connector P23, was removed and replaced per B/P requirements. After megohm and continuity checks, the rework was acceptable. In the mating connector, bent pin R was straightened per DPS 54002. |

TABLE II (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A196160 2-20-67 | The transducer kit, P/N 1B40242-545, S/N 545-12, for measurement D104, failed high and low RACS requirements of H&CO 1B59594. High output was 0.179 vdc, should be 4.000 ± 0.100 vdc and low output was 0.185 vdc, should be 1.000 ± 0.100 vdc. This defect was noted in the course of H&CO 1B59594. | The defective transducer kit was returned to the vendor for rework to applicable blueprint and specifications. |
| A196161 2-22-67 | The end cap assembly on the actuator piston close "C" port on directional control valve, P/N 1A49988-1, S/N 0007, leaked at the rate of 630 scim. Maximum allowable leakage was 50 scim per H&CO 1B59430. Defect noted during operation of H&CO 1B59430. | Defective directional control valve was removed and replaced per FARR A228585. |
| A196162 2-27-67 | Leakage at the connection of cap, P/N MC177C4W, to pipe assembly, P/N 1B58807-1, could not be stopped by retorquing. Defect noted during operation of H&CO 1B59431. | The crush washer, P/N VSF1015C4, was installed, stopping the leakage. |
| A196163 2-27-67 | On the J-2 engine, the inner edge of the flange of line, P/N NA5-260147-2, was damaged in two places. Defect noted during operation of H&CO 1B59433. | The damaged areas were ground and cleaned per Engineering instructions. The rework was acceptable. |
| A196165 3-1-67 | The potting compound on bus connector, P/N 1B57771-561-001, extended 0.030 in. beyond the surface of the mounting flange. It should have been flush with the mounting surface. | The bus connector was returned to the vendor for rework to the applicable B/P and specifications, or replacement. |

TABLE II (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A196166 3-1-67 | There was a 3/64 in. diameter hole in the potting compound on bus connector, P/N 1B57771-559. The hole should not have exceeded 1/32 in. diameter. | The bus connector was sent to the vendor for rework to the applicable B/P and specifications, or replacement. |
| A196167 3-1-67 | There was a 1/16 in. hole in the potting compound on one bus connector, P/N 1B57771 -557. The hole should not have exceeded 1/32 in. diameter. | The bus connector was sent to the vendor for rework to the applicable B/P and specifications, or replacement. |
| A196169 3-2-67 | There was a 1/16 in. hole in the potting compound on one bus connector, P/N 1B57771 -557. The hole should not have exceeded 1/32 in. diameter. | The bus connector was sent to the vendor for rework to the applicable B/P and specifications, or replacement. |
| A196170 3-2-67 | On two bus connectors, P/N 1B57771-569, the potting compound extended 0.020 in. beyond the surface of the mounting flange and did not adhere to the edge of the connector. | The bus connectors were sent to the vendor for rework to the applicable B/P and specifications, or replacement. |
| A196171 3-2-67 | During the DDAS test, H&CO 1B59594, transducer 404MT629, P/N 1B40242-1, S/N 1-5 for measurement D208, channel CP1-BO-01-08, (erroneously recorded as measurement D237 in the H&CO) printed out as 15.295 psia at ambient. Printout should have been 14.7 ± 0.5 psia. Retest per A659-1B40242-1-PATP1 showed a repeatability of 0.48 per cent of full scale, should have been 0.200 per cent maximum. | The transducer was removed and replaced by S/N 1-53. After retest, the unit was reworked to the applicable B/P and specifications. The kit, S/N 1-53 was acceptable for use. |

TABLE II (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A196172<br>3-2-67 | Pin E of plug 404W7P12, wire harness, P/N 1B66496-1, was damaged and pulled out of the insert. Defect noted during H&CO 1B59590. | Connector P12 was removed and replaced. The rework was acceptable. |
| A196173<br>3-3-67 | There were two arc-shaped indentations in the sealing surface of the flange of pipe assembly, P/N 1B52559-1. (Reference FARR A196168). Defect noted during H&CO 1B59433. | After retest per B/P 1B59433 failed to indicate any leakage, the pipe assembly was accepted for use. |
| A196174<br>3-8-67 | During the propulsion tank system leak check, H&CO 1B59432, the leak check from the common bulkhead to transducer D237 could not be accomplished and the 2.5 $\pm$ 0.5 psig pressure at transducer D237 could not be verified, because of sealing compound in the port accommodating fitting, P/N 1B49262-1. The fitting should have not been sealed. | Excessive foam and sealing compound was removed from the ports for fittings, P/N's 1B49262-1 and 1B29959-1. After reassembly per B/P requirements and retest, the reworked fittings were accepted for use. |
| A196175<br>3-21-67 | During the all systems test, H&CO 1B65533, measurement D7, transducer 401-3MTP61, P/N NA5-27412T2T, S/N 1483A, had a 3 per cent average noise level and measurement D10, transducer 401-3MTP4, P/N NA5-27412T10T, S/N 4826A, had a 4 per cent noise level, both for about 10 minutes while the chilldown inverter was on. This exceeded the requirements of 2 to 5 per cent maximum peak-to-peak noise level for not over 1 second duration, specified in report SM46847 and used for evaluation of the open loop telemetry data. | Acceptable to Engineering for use as is. |

TABLE II (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A216722<br>2-16-67 | Sixty-one Deutsch bus connectors, P/N's 1B57771-557, -559, -561, -563, -565, and -569 were suspected of faulty operation due to insufficient primer between the polyurethane potting and the unplated surface of the modules. | The modules were reworked per salvage SEO 1B57771-001.. |
| A228577<br>3-22-67 | On wire harness 404W30, P/N 1B58678, pins 4 and 5 of connector P6, pin 9 of connector P9 and pin 11 of connector P10, were recessed 0.030 to 0.041 in. from the pin barrel end; should have been recessed 0.065 $\pm$ 0.015 in. per DPS 54002-10. Pin 12 of connector P7 had the pin barrel recessed 1/8 in. below the grommet front face. | The back shell adaptors were removed from the noted connectors and the coaxial fitting pin recess depth was remeasured. The pins were reinstalled per blueprint requirements. |
| A228578<br>3-22-67 | On wire harness 411W11, P/N 1B58093, pins 4 and 5 in connector P3, and pins 8 and 9 in connector P5, were recessed 0.045 to 0.048 in., and pin 8 in connector P13 was recessed 0.096 in., from the pin barrel end. Recess should have been 0.065 $\pm$ 0.015 in. per DPS 54002-10. Pin 4 of connector P3 also had the pin barrel recessed 1/8 in. below the grommet front face. | The noted coaxial contacts were removed and remeasured. The pins were reinstalled per the blueprint requirements. The rework was acceptable to Engineering for use. |
| A228579<br>3-22-67 | On forward skirt wire harness 410W200, P/N 1B58138-1, connector P4 was bent and gouged at the lock ring and shell. | Connector P4 was removed and replaced. After megohmeter and continuity checks, the rework was accepted for use. |

TABLE II (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A228581<br>3-28-67 | Inspection of the P/N 1A74633-517, cylindrical tank, revealed discolorations at forward and aft tank weld seams. Defect was noted during final inspection. | Defects were sanded and repainted. Rework was acceptable to Engineering for use. |
| A228582<br>4-3-67 | During the propellant tank system leak check, H&CO 1B65763, of the stage, P/N 1A74633-517, several leaks in excess of $1 \times 10^{-3}$ cc/second were found. The locations were:<br>a. Leak port between fuel ducts, P/N's 1A49320-501-001 and -507.<br>b. $LH_2$ sense line adapter, P/N 1B64115-1.<br>c. $LH_2$ tank duct, P/N 1A94469-503, at tank flange.<br>d. $LH_2$ vent valve to quick disconnect.<br>e. The pipe assembly, P/N 1B64864-1, to vent valve.<br>f. LOX vent elbow, P/N 1A77116-1.<br>g. LOX sense line, P/N 1B64127-1, to hand valve. | Defects a., c., and f. were corrected by replacing the conoseals. Defects b., d., e., and g. were corrected by retorquing the B-nuts. The rework was acceptable to Engineering for use. |
| A228583<br>4-6-67 | Pipe assembly P/N 1B64127-1 had radial scratches on sealing surface of flare seat on the upstream end. Defect noted during leak test in post checkout per A659-1B65763 -1-PAT6-BT3. | Scratches were polished out per DPS 10001 and cleaned per DPS 43000. The rework was acceptable to Engineering for use. |

TABLE II (Continued)

| FARR NO. | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A196151 2-10-67 | Pin B of plug J2 on level sensor, P/N 1A68710 -509, S/N D55, was bent. The mating connector 405W1P6 had the insert punctured. These defects were noted during the stage power setup H&CO 1B59590. | Pin B was straightened per DPS 54002 and remated three times. The rework was acceptable for use. |
| A196152 2-13-67 | Liquid level control unit 411A61A219, P/N 1A68710-509, S/N D71, could not be adjusted to 28 $\pm$ 2 vdc per H&CO 1B59821. This defect was noted during operation of H&CO 1B59821. | The control unit was removed and control unit, P/N 1A68710-509, S/N E105, was installed. Retest confirmed that S/N D71 could not be properly adjusted and it was returned to the vendor for rework or replacement. |
| A196153 2-13-67 | Liquid level control unit 404A63A221, P/N 1A68710-511, S/N D1, could not be adjusted to 28 $\pm$ 2 vdc per H&CO 1B59821. This defect was noted during calibration of the level sensors and control units per H&CO 1B59821. | The control unit was removed and control unit, P/N 1A68710-511, S/N D123, was installed. Retest confirmed that S/N D1 could not be properly adjusted and the unit was returned to the vendor for rework or replacement. |
| A196154 2-14-67 | On power divider 411A97A56, P/N 1B38999-1, S/N 00019, coax connector J6 was loose on the base. Defect noted during operation of 1B66927. | Four screws were tightened to securely fasten J6. The rework was acceptable. |
| A196155 2-15-67 | Power divider 411A97A56, P/N 1B38999-1, S/N 026, failed per H&CO 1B66927. A 21 db isolation value noted between 411W12P1 and 411W13P1 should have been 25 db minimum. This defect was recorded during operation of H&CO 1B66992. | After retest failed to duplicate the defect, the unit was accepted for use. |

TABLE II (Continued)

| FARR NO | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A196156 2-16-67 | Channel calibration command decoder assembly 404A72A200, P/N 1A74053-503, S/N 263, failed to maintain a constant 28 vdc output control signal for channel DP1-B0-13-04, measurement D19. The 28 vdc was maintained about 1 second, then dropped to 0 vdc. Defect noted during DDAS test, H&CO 1B59594. | The decoder assembly was removed and assembly, S/N 328, was installed. Retest of S/N 263 per B/P 1B37740 showed that the decoder assembly output signals had no relationship to the programmed logic input signals. The unit was returned to the vendor for rework or replacement. |
| A196157 2-17-67 | One wire on wire harness 404W7, P/N 1B66496-1, had insulation cracked and damaged, 36 in. from plug P-12. Defect noted during H&CO 1B59590 operation. | The damaged wire was removed and replaced. The rework was acceptable. |
| A196158 2-30-67 | On the $LH_2$ pressurization control module assembly, P/N 1B55200-505, S/N 1019, the check valve reverse seat leakage was 10,000 scim at 300 $\pm$ 20 psia and 730 scim at 15 $\pm$ 5 psia. The maximum allowable leakages, respectively, were 10 scim and 50 scim. Defect noted during H&CO 1B59429 operation. | The vendor disassembly found that about 35 per cent of the Kel-F seat was missing from the poppet. The module was returned to the vendor for rework or replacement. Check valve, S/N 1021, was installed on the stage and checked out satisfactorily. |

TABLE II (Continued)

| FARR NO | DESCRIPTION OF DEFECTS | DISPOSITION |
|---|---|---|
| A233599<br>1-31-67 | On panel A99 in the forward skirt, receptacles J1 and J2 of wire harness 411A99A10W1, P/N 1B54269, had the following pins recessed and damaged Pins D, E, S, R, X, f, e, K, and r in J1, and pins B, F, G, J, R, Z, f, m, e, P, r and d, in J2 | The damaged pins in both receptacles were replaced per DPS 54002-5. After megohm and continuity checks, the rework was acceptable for use. |
| A248601<br>3-22-67 | At reference locations 403MT736 and 403MT737, on stringer 19, 18 in aft of the thrust structure attachment ring, shock mount isolator, P/N B21-BC-05 had 0.008 in. deep dents in all four shock mounts | The defects were acceptable for use without rework |
| A248685<br>2-20-67 | Transducer, P/N 1B39293-1, S/N 17, for measurement D160, indicated 4.112 vdc on the high RACS test Indication should be 4.000 ± 1.000 | The defective S/N 17 was removed and replaced by S/N 80. The rework was acceptable. |
| A248701<br>3-14-67 | On the fuel mass sensor, P/N 1A48431-505, S/N D5, the reliability if the spot welds on the fixed mount sleeve, P/N 973500, was suspect Information and request for rejection per Minneapolis - Honeywell TWX, dated 3/7/67. | Acceptable for use. |

FORM NO 30-846-1 (9 65)

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